DEPARTMENT OF THE NAVY (DON)
16.2 Small Business Innovation Research (SBIR)
Proposal Submission Instructions

INTRODUCTION

Responsibility for the implementation, administration, and management of the Department of the Navy (DON) SBIR Program is with the Office of Naval Research (ONR). The Director of the DON SBIR Program is Mr. Robert Smith, robert.l.smith6@navy.mil. For program and administrative questions, please contact the Program Managers listed in Table 1; **do not** contact them for technical questions. For technical questions about the topic, contact the Topic Authors listed for each topic during the period **22 April 2016 through 22 May 2016.** Beginning **23 May 2016**, the SBIR/STTR Interactive Technical Information System (SITIS) (https://sbir.defensebusiness.org/) listed in Section 4.15.d of the DoD SBIR Program Solicitation must be used for any technical inquiry. For inquiries or problems with electronic submission, contact the DoD SBIR/STTR Help Desk at 1-800-348-0787 (9:00 a.m. to 6:00 p.m. ET).

TABLE 1: DON SYSTEMS COMMANDS (SYSCOM) SBIR PROGRAM MANAGERS

Topic Numbers	Point of Contact	Activity	Email
N162-073 to N162-081	Mr. Jeffrey Kent	MARCOR	jeffrey.a.kent@usmc.mil
N162-082 to N162-106	Ms. Donna Attick	NAVAIR	donna.moore@navy.mil
N162-107 to N162-115	Mr. Dean Putnam	NAVSEA	dean.r.putnam@navy.mil
N162-116	Mr. Mark Deebel	NAVSUP	mark.deebel@navy.mil
N162-117 to N162-118	Ms. Karen Lagman	NSMA	karen.lagman@navy.mil
N162-119 to N162-133	Ms. Lore-Anne Ponirakis	ONR	loreanne.ponirakis@navy.mil
N162-134 to N162-135	Mr. John Thom	SPAWAR	john.thom@navy.mil
N162-136	Mr. Mark Hrbacek	SSP	mark.hrbacek@ssp.navy.mil

The DON's SBIR Program is a mission oriented program that integrates the needs and requirements of the DON's Fleet through R&D topics that have dual-use potential, but primarily address the needs of the DON. Companies are encouraged to address the manufacturing needs of the defense sector in their proposals. Information on the DON SBIR Program can be found on the DON SBIR/STTR website at www.navysbir.com. Additional information pertaining to the DON's mission can be obtained from the DON website at www.navy.mil.

PHASE I GUIDELINES

Follow the instructions in the DoD SBIR Program Solicitation at https://sbir.defensebusiness.org/ for program requirements and proposal submission guidelines. Please keep in mind that Phase I should address the feasibility of a solution to the topic. It is highly recommended that proposers follow the DON proposal template located at www.navysbir.com/submission.htm as a guide for structuring proposals. Inclusion of cost estimates for travel to the sponsoring SYSCOM's facility for one day of meetings is recommended for all proposals.

DON SBIR PHASE I PROPOSAL SUBMISSION REQUIREMENTS

The following MUST BE MET or the proposal will be deemed noncompliant and will be REJECTED.

- **Technical Volume.** Technical Volumes shall not exceed **20** pages. The DON requires proposers to include, within the **20-page limit**, an Option that furthers the effort and will bridge the funding gap between the end of the Phase I and the start of the Phase II. Phase I Options are typically exercised upon selection of the Phase II. Tasks for both the Base and the Option should be clearly identified in the 20-page Technical Volume. Any other information provided (e.g. table of contents, letters of support, references, appendices) will count toward the 20-page limitation.

- **Cost.** The Phase I Base amount shall not exceed $80,000 and the Phase I Option amount shall not exceed $70,000. Costs for the Base and Option should be separate and identified on the Proposal Cover Sheet and in the Cost Volume.

- **Period of Performance**. The Phase I Base and Option Periods of Performance shall not exceed six months each.

DON SBIR PHASE I PROPOSAL SUBMISSION CHECKLIST

- **Proposal Template.** It is highly recommended that proposers follow the DON proposal template located at www.navysbir.com/submission.htm.

- **Subcontractor, Material, and Travel Cost Detail.** In the Cost Volume, firms shall provide sufficient detail for the subcontract, material and travel costs. Use the "Explanatory Material Field" in the DoD Cost Volume worksheet for this information. Material costs should include at a minimum listing of items and cost per item. Travel costs should include at a minimum the purpose of the trip, number of trips, location, length of trip, and number of personnel. When a proposal is selected for award, you must be prepared to submit further documentation to the Component Contracting Officer to substantiate costs (e.g., an explanation of cost estimates for equipment, materials, and consultants or subcontractors).

- **Performance Benchmarks.** Firms must meet the two benchmark requirements for progress towards Commercialization as determined by the Small Business Administration (SBA) on June 1 each year. Please note that DON applies performance benchmarks at time of proposal submission, not at time of contract award.

- **Discretionary Technical Assistance (DTA).** If DTA is proposed, the information required to support DTA should be added in the "Explanatory Material Field" of the DoD Cost Volume worksheet. If proposing DTA, a combined total of up to $5,000 may be added to the Base or Option periods.

DISCRETIONARY TECHNICAL ASSISTANCE (DTA)

The SBIR Policy Directive section 9(b), allows the DON to provide DTA to its awardees to assist in minimizing the technical risks associated with SBIR projects and commercializing products and processes. Firms may request, in their Phase I and Phase II proposals, to contract these services themselves in an amount not to exceed $5,000 per year. This amount is in addition to the award amount for the Phase I or Phase II project.

Phase I awardees that propose more than $150,000 in total funding (Base, Option, and DTA) may not receive a purchase order. Purchase orders are a type of Simplified Acquisition Procedure (SAP) intended to reduce administrative costs, promote efficiency and economy in contracting, and avoid unnecessary burdens for agencies and contractors. The need to issue a Firm Fixed Price (FFP) contract may result in contract delays if the SYSCOM normally issues purchase orders for Phase I awards. **FOR ONR TOPICS ONLY:** The total Phase I award amount, including DTA, cannot exceed $150,000.

Approval of direct funding for DTA will be evaluated for approval by the DON SBIR office if the firm's proposal (1) clearly identifies the need for assistance (purpose and objective of required assistance), (2) provides details on the provider of the assistance (name and point of contact for performer); and unique skills/specific experience to carry out the assistance proposed, and (3) the cost of the required assistance (costs and hours proposed or other details on arrangement that would justify the proposed expense). This information must be included in the firm's cost proposal specifically identified as "Discretionary Technical Assistance" and cannot be subject to any profit or fee by the requesting SBIR firm. In addition, the provider of the DTA may not be the requesting firm, an affiliate of the requesting firm, an investor of the requesting firm, or a subcontractor or consultant of the requesting firm otherwise required as part of the paid portion of the research effort (e.g. research partner, consultant, tester, or administrative service provider). Failure to include the required information in the proposal will result in the request for DTA being disapproved. Exceeding proposal limits identified for Phase I ($150,000 for Base, Option, and DTA) without including the required identification of DTA will result in the proposal's REJECTION without evaluation.

If a firm requests and is awarded DTA in a Phase II proposal, it will be eliminated from participating in the DON SBIR/STTR Transition Program (STP), the DON Forum for SBIR/STTR Transition (FST), and any other assistance the DON provides directly to awardees.

All Phase II awardees not receiving funds for DTA in their award must attend a one-day DON STP meeting during the second year of the Phase II. This meeting is typically held in the summer in the Washington, DC area. Information can be obtained at: http://www.navysbir.com/Transition.htm. Awardees will be contacted separately regarding this program. It is recommended that Phase II cost estimates include travel to Washington, DC for this event.

EVALUATION AND SELECTION

The DON will evaluate and select Phase I and Phase II proposals using the evaluation criteria in Sections 6.0 and 8.0 of the DoD SBIR Program Solicitation respectively, with technical merit being most important, followed by qualifications of key personnel and commercialization potential of equal importance. Due to limited funding, the DON reserves the right to limit awards under any topic and only proposals considered to be of superior quality will be funded. **NOTE: The DON does NOT participate in the FAST Track program.**

Approximately one week after Phase I solicitation closing, e-mail notifications that proposals have been received and processed for evaluation will be sent. Consequently, e-mail addresses on the proposal coversheets must be correct.

Requests for a debrief must be made within 15 calendar days of non-award notification. Please note the DON debrief request period is shorter than the DoD debrief request period specified in section 4.10 of the DoD Instructions

Protests of Phase I and II selections and awards shall be directed to the cognizant Contracting Officer for the DON Topic Number. Contact information for Contracting Officers may be obtained from the DON SYSCOM SBIR Program Managers listed in Table 1.

CONTRACT DELIVERABLES

Contract deliverables are typically progress reports and final reports. Deliverables required by the contract, shall be uploaded to https://www.navysbirprogram.com/navydeliverables/.

AWARD AND FUNDING LIMITATIONS

The DON typically awards a Firm Fixed Price (FFP) contract or a small purchase agreement for Phase I. In accordance with SBIR Policy Directive section 4(b)(5), there is a limit of one sequential Phase II award per firm per topic. Additionally, in accordance with SBIR Policy Directive section 7(i)(1), each award may not exceed the award guidelines (currently $150,000 for Phase I and $1 million for Phase II, excluding DTA) by more than 50% (SBIR/STTR program funds only) without a specific waiver granted by the SBA.

TOPIC AWARD BY OTHER THAN THE SPONSORING AGENCY

Due to specific limitations on the amount of funding and number of awards that may be awarded to a particular firm per topic using SBIR/STTR program funds (see above), Head of Agency Determinations are now required (for all awards related to topics issued in or after the SBIR 13.1/STTR 13A solicitation) before a different agency may make an award using another agency's topic. This limitation does not apply to Phase III funding. Please contact the original sponsoring agency before submitting a Phase II proposal to an agency other than the one that sponsored the original topic. (For DON awardees, this includes other DON SYSCOMs.)

TRANSFER BETWEEN SBIR AND STTR PROGRAMS

Section 4(b)(1)(i) of the SBIR Policy Directive provides that, at the agency's discretion, projects awarded a Phase I under a solicitation for SBIR may transition in Phase II to STTR and vice versa. A firm wishing to transfer from one program to another must contact its designated technical monitor to discuss the reasons for the request and the agency's ability to support the request. The transition may be proposed prior to award or during the performance of the Phase II effort. No transfers will be authorized prior to or during the Phase I award. Agency disapproval of a request to change programs will not be grounds for granting relief from any contractual performance requirement(s) including but not limited to the percentage of effort required to be performed by the small business and the research institution (if applicable). All approved transitions between programs must be noted in the Phase II award or an award modification signed by the contracting officer that indicates the removal or addition of the research institution and the revised percentage of work requirements.

ADDITIONAL NOTES

Due to the short timeframe associated with Phase I of the SBIR process, the DON does not recommend the submission of Phase I proposals that require the use of Human Subjects, Animal Testing, or Recombinant DNA. For example, the ability to obtain Institutional Review Board (IRB) approval for proposals that involve human subjects can take 6-12 months, and that lengthy process can be at odds with the Phase I goal for time to award. Before the DON makes any award that involves an IRB or similar approval requirement, the proposer must demonstrate compliance with relevant regulatory approval requirements that pertain to proposals involving human, animal, or recombinant DNA protocols. It will

not impact the DON's evaluation, but requiring IRB approval may delay the start time of the Phase I award and if approvals are not obtained within two months of notification of selection, the decision to award may be terminated. If the use of human, animal, and recombinant DNA use is included under a Phase I or Phase II proposal, please carefully review the requirements at: http://www.onr.navy.mil/About-ONR/compliance-protections/Research-Protections/Human-Subject-Research.aspx. This webpage provides guidance and lists approvals that may be required before contract/work can begin.

Due to the typical lengthy time for approval to obtain Government Furnished Equipment (GFE), it is recommended that GFE is not proposed as part of the Phase I proposal. If GFE is proposed and is determined during the proposal evaluation process to be unavailable, proposed GFE may be considered a weakness in the proposal.

For topics indicating ITAR restrictions or the potential for classified work, there are generally limitations placed on disclosure of information involving topics of a classified nature or those involving export control restrictions, which may curtail or preclude the involvement of universities and certain non-profit institutions beyond the basic research level. Small businesses must structure their proposals to clearly identify the work that will be performed that is of a basic research nature and how it can be segregated from work that falls under the classification and export control restrictions. As a result, information must also be provided on how efforts can be performed in later Phases if the university/research institution is the source of critical knowledge, effort, or infrastructure (facilities and equipment).

PHASE II GUIDELINES

All Phase I awardees will be allowed to submit an **Initial** Phase II proposal for evaluation and selection. The Phase I Final Report, Initial Phase II Proposal, and Transition Outbrief (as applicable), will be used to evaluate the offeror's potential to progress to a workable prototype in Phase II and transition technology in Phase III. Details on the due date, content, and submission requirements of the Initial Phase II Proposal will be provided by the awarding SYSCOM either in the Phase I award or by subsequent notification. **NOTE: All SBIR/STTR Phase II awards made on topics from solicitations prior to FY13 will be conducted in accordance with the procedures specified in those solicitations (for all DON topics, this means by invitation only).**

Section 4(b)(1)(ii) of the SBIR Policy Directive permits the Department of Defense and by extension the DON, during fiscal years 2012 through 2017, to issue a Phase II award to a small business concern that did not receive a Phase I award for that R/R&D. **NOTE:** The DoN will NOT be exercising this authority for SBIR Phase II awards. **Therefore, in order for any small business firm to receive a Phase II award, the firm must be a recipient of a Phase I award under that topic and submit an Initial Phase II proposal.**

The DON typically awards a cost plus fixed fee contract for Phase II. The Phase II contracts can be structured in a way that allows for increased funding levels based on the project's transition potential. To accelerate the transition of SBIR-funded technologies to Phase III, especially those that lead to Programs of Record and fielded systems, the Commercialization Readiness Program was authorized and created as part of section 252 of the National Defense Authorization Act of Fiscal Year 2006. The statute set-aside is 1% of the available SBIR funding to be used for administrative support to accelerate transition of SBIR-developed technologies and provide non-financial resources for the firms (e.g. the DON's SBIR/STTR Transition Program).

PHASE III GUIDELINES

A Phase III SBIR award is any work that derives from, extends, or completes effort(s) performed under

prior SBIR funding agreements, but is funded by sources other than the SBIR Program. Thus, any contract or grant where the technology is the same as, derived from, or evolved from a Phase I or a Phase II SBIR/STTR contract and awarded to the company that was awarded the Phase I/II SBIR is a Phase III SBIR contract. This covers any contract/grant issued as a follow-on Phase III SBIR award or any contract/grant award issued as a result of a competitive process where the awardee was an SBIR firm that developed the technology as a result of a Phase I or Phase II SBIR. The DON will give SBIR Phase III status to any award that falls within the above-mentioned description, which includes assigning SBIR Data Rights to any noncommercial technical data and/or noncommercial computer software delivered in Phase III that was developed under SBIR Phase I/II effort(s). Government prime contractors and/or their subcontractors follow the same guidelines as above and ensure that companies operating on behalf of the DON protect the rights of the SBIR company.

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NAVY SBIR 16.2 Topic Descriptions

N162-073 TITLE: Data in Transit Encryption Algorithms for Hand-held devices and Man-pack Radios

TECHNOLOGY AREA(S): Information Systems

ACQUISITION PROGRAM: PMO MC3, Program Management Office, Marine Air-Ground Task Force (MAGTF) Command, Control and Command

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 5.4.c.(8) of the solicitation. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop Encryption Algorithms for Hand-held devices and Man-pack Radios. The encryption algorithm is to provide Commercial Solutions for Classified (CSfC) protection and integrity and confidentiality of transmitted information. The transmitted information will include Command and Control (C2) messages and Precision Location Information (PLI) for dismounted radios and tactical hand-held devices while providing the ability to be certified at the classified level, agnostic to the network used (i.e. encrypt the data portion of the packet only).

DESCRIPTION: Marine Corps Systems Command (MARCORSYSCOM) provides advanced algorithms for use in Command and Control (C2) network solutions to the Marine Corps. In an operational environment, dismounted Marines may encounter information operations against them in trying to decrypt or infiltrate Marine Corps Enterprise Networks (MCEN) or other information threats. These attacks will be unpredictable in frequency and occurrence and may include electronic warfare directed attacks. Dismounted Marines operate tactical hand-held devices or man-pack radios to send Command and Control (C2) messages as well as Precision Location Information (PLI) messages at the tactical edge. Additionally, Dismounted Marines have relied on the use of Control Cryptographic Items (CCI) type 1 encryptors for protection of classified information to the tactical edge while maintain connectivity to the MCEN Secret Internet Router Protocol Network (SIPRnet). With the new addition of the Commercial Solutions for Classified (CSfC) office, the National Security Agency (NSA) in partnership with the Defense Information Systems Agency (DISA) have provided an alternate means to protect classified information utilizing double encryption instead of requiring type 1 encryption. The development of technology solutions for this type of environment creates several challenges. Currently approved algorithms allowed require point to point connectivity as well as a dual vendor requirement. Additionally, it is desired for the algorithm to work and be certified for use in both the Windows and Android operating environments. Presently, the solution that has been deployed is to use a type 1 CCI device, however, the inclusion of Data in Transit algorithms may allow for the use of wireless hand-held devices, integrated wireless to radios and also the ability to interoperate with coalition forces that may not have type 1 CCI. At this time, there is no robust, viable technology solution that provides multicast transmission for this ongoing need in the application cited.

MARCORSYSCOM is looking for a solution that must be able to provide protection in a multicast transmission such as those in C2 and PLI messages. Agnostic Data in Transit algorithms, will initially be used for Marine Corps radios AN/PRC-117G and for the new acquisition program Marine Corps Handheld (MCH). The following hand-held and man-pack tactical radios may also use the above mentioned algorithm: AN/PRC-150, AN/PRC-117F, AN/PRC-117G and AN/PRC-152 (Ref 1). The radios will be used as a transmission medium only and will be used for proof of concept testing by the Program Management Office (PMO). Concepts proposed must provide the impact on the availability and throughput (rate of transmission) of messages while still providing integrity and confidentiality. Proposers must address how their technology solution(s) provides the ability to protect classified information, any novel technology combination (algorithms) used to achieve a classified protection, and any

applicable algorithm performance information. These algorithms should meet the requirements for protection of classified information per the CSfC process (reference 2). Proposers should employ open architecture designs principles as much as is practicable to protect only the payload portion of an Internet Protocol (IP) message. Preference will be given to solutions that have an overhead of less than 6% (4% overhead for the TCP/IP header plus 2% overhead for encryption) when used in current Marine Corps systems (MCH connected to radios) for a notional 1 kilobyte message. Lastly, the solution should describe any current or previous experience with the CSfC process to include the ability to be certified by NSA which is an ultimate requirement for this technology.

PHASE I: The company will develop a novel data in transit algorithm that a hand-held or man-pack radio may use to protect the integrity and confidentiality of data to the requirements described above. The company will demonstrate the feasibility of the concepts in meeting Marine Corps needs through modeling and simulation and will establish the concepts can be developed into a useful product for the Marine Corps. Feasibility may be established by testing and/or analytical modeling, as appropriate. The company will provide a Phase II development plan with performance goals and key technical milestones, and that will address technical risk reduction as well as the plan for certification through the CSfC process. The company should develop a solution with means to protect the algorithm from disclosure for inclusion in the CSfC process and subsequent NSA CSfC certification if selected for a Phase II.

The Phase I effort will not require access to classified information. If need be, data of the same level of complexity as secured data will be provided to support Phase I work. The Phase II effort will likely require secure access, and the contractor will need to be prepared for personnel and facility certification for secure access.

PHASE II: Based on the results of Phase I and the Phase II development plan, the small business will develop a scaled prototype of the algorithm for evaluation. The prototype will be used on both Android and Windows Operating System Environments to meet the performance goals defined in the Phase II development plan and the Marine Corps requirement for wireless transmission and protection of classified information, with a preference and initial use on the Android Operating System. Additionally, the small business shall carry this product through the CSfC process in which the particular algorithms used may become classified when certified. The performer will still be able to use the certified technology for commercial use but may have disclosure restrictions imposed during the CSfC certification process. System performance will be demonstrated through prototype inclusion of a software encryption of the algorithm on a handheld device and evaluated in both wired and wireless transmission to man-pack radios by integrated testing with existing Program Office events. Evaluation results will be used to refine the prototype into an initial design meeting Marine Corps requirements. The company will prepare a Phase III development plan to transition the technology for Marine Corps use in both the Windows and Android operating system environments with initial preference to the Android Operating system. Additionally, the company should provide in the plan for a transition to both coalition and Naval forces interoperating with Marine Corps.

PHASE III DUAL USE APPLICATIONS: If Phase II is successful, the company will be expected to support the Marine Corps in transitioning the technology for Marine Corps, Navy and coalition use. The company will integrate the algorithm for inclusion in a handheld form factor to determine its effectiveness in an operationally relevant environment. The small business will support the Marine Corps for test and validation to certify and qualify the system for Marine Corps use. Private Sector Commercial Potential: Municipalities, law enforcement, and first responders also use radios. New data in transit algorithms would also be attractive to these applications for integrity and confidentiality of the data. Such applications could be applied to both handheld or vehicle mounted applications, shipboard applications and interoperability of coalition forces without the use of CCI.

Additionally, commercial use of data in transit algorithms that provide protection at the classified level are also appropriate for use with health and banking data and almost any application which requires data protection.

REFERENCES:
1. AN/PRC-150 Military HF Radio, AN/PRC-117G Wideband Tactical Radio, AN/PRC-152 Multiband Radio. http://rf.harris.com/capabilities/tactical-radios-networking

2. National Security Agency Commercial Solutions for Classified. https://www.nsa.gov/ia/programs/csfc_program/

KEYWORDS: tactical radio; tactical; handheld; AN/PRC-150; AN/PRC-117F; AN/PRC-117G; AN/PRC-152

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Questions may also be submitted through DoD SBIR/STTR SITIS website.

N162-074 TITLE: Artificial Intelligence (AI)-based C2 Digital Assistant

TECHNOLOGY AREA(S): Information Systems

ACQUISITION PROGRAM: PMM-202 (AC2SN), PEO Land Systems

OBJECTIVE: The objective is to develop an artificial intelligence (AI)-based Command and Control (C2) digital assistant that uses advanced computing techniques such as machine learning and natural language processing to provide answers to complex mission-specific questions to enhance battlespace decision making.

DESCRIPTION: The Marine Corps seeks to leverage advanced artificial intelligence (AI) technologies to reduce information overload, improve situational awareness (SA) and collaboration, and aid in Commander decision-making. The cognitive demands of future network-centric forces are overwhelming and commanders often get "caught in the weeds" and suffer from the glare of information. Intelligent assistants such as Apple's Siri, Google Now, or Facebook's "M" are commonplace in commercial industry yet similar products do not exist for military commanders tasked with managing an increasingly complex battlespace. New "big data" computing techniques such as predictive analytics, deep machine learning, distributed rules engines, and real-time contextual search can significantly ease the information burden and enable more effective and efficient decision making. These computing techniques not only identify patterns across multiple data sets but they recommend courses of action and evaluate proposed actions.

The aim of AI techniques embedded in an intelligent decision support system such as the proposed Command and Control (C2) digital assistant is to enable computer automation while emulating human capabilities as closely as possible.

The C2 digital assistant is envisioned to be integrated into the Common Aviation Command and Control System (CAC2S), an Acquisition Category I (ACAT I), Major Automated Information System (MAIS) that modernizes the air command and control suite in support of the Marine Aircraft Wings. The program replaces and modernizes the currently fielded, stove piped, and rapidly becoming obsolete aviation C2 equipment and facilities that support the Marine Air-Ground Task Force in Joint and combined air operations today. The Program received a positive Milestone C Decision in February 2015 and is ready to enter IOT&E in April 2016. The C2 digital assistant enhances the Command Tools function of CAC2S.

The AI-based C2 digital assistant will be a secure, open architecture system that runs continuously in the background and learns from its environment. It will utilize open-source libraries, software development kits (SDKs), and application programming interfaces (APIs) to the greatest extent possible and employ well-defined, well-documented interfaces to maximize modularity and extensibility. It will be capable of interpreting ad hoc natural language queries with minimal training and learn progressively as historical behaviors of both friendly and hostile forces are observed over time. By searching through vast troves of persistent unstructured data, the AI-based C2 digital assistant will greatly improve warfighting outcomes and enable commanders to compose "what if's" based on

intelligence information, local and remote sensor data, logistics and weapons information, and battle damage assessment activities. For example, disparate radio frequency emissions scattered across the battlefield may indicate the presence of an Integrated Air Defense System (IADS) and pose a threat to aviation assets. Using the C2 digital assistant to query previously detected RF emissions, the results will expose the presence of IADS assets and alter the Commander to apply appropriate action.

PHASE I: The small business will develop a concept for a high-level information architecture and componentized system design to meet the requirements for the AI-based C2 digital assistant described above. The company will document the feasibility and limitations of the digital assistant based on research and controlled testing of underlying concepts. The small business will provide a Phase II development plan with performance goals, key technical milestones, and risk reduction activities.

PHASE II: Based on the results of Phase I and the Phase II development plan, the company will develop a scaled prototype of the C2 digital assistant for evaluation and testing. The prototype will be evaluated to determine its capability in meeting the performance goals defined in the Phase II development plan and its ability to assist with efficient and effective decision making in a tactical environment. System performance will be demonstrated through prototype evaluation, modeling and simulation, and use case analysis. Phase II will be classified to the SECRET level. Battlefield data such as Tactical Digital Information Links (TADIL), sensor data, composite tracking data, and tactical intelligence information are examples of data that a C2 digital assistant will evaluate and assess. Testing is envisioned to be part of CAC2S Developmental Testing and Follow-on Operational Test and Evaluations at the Weapons and Tactics Instructor Courses in Yuma, AZ. Evaluation results will be used to refine the prototype implementation into an initial design that will meet Marine Corps requirements. The company will prepare a Phase III development plan to transition the technology to Marine Corps use.

PHASE III DUAL USE APPLICATIONS: If Phase II is successful, the small business will be expected to support transitioning the technology for Marine Corps use in operational command posts and C2 agencies. The company will develop and integrate a full-scale AI-based C2 digital assistant for evaluation to determine its effectiveness in an operationally relevant environment. The company will provide test and validation support to certify and qualify the system for integration into C2 systems such as the Common Aviation Command and Control System (CAC2S). Private Sector Commercial Potential: The potential for commercial application of an extensible AI-based digital assistant is high. Possible avenues for employment include search and rescue, first responder applications, law enforcement, homeland security, special operations, cyber defense, and Internet of Things (IoT) applications for consumers and businesses.

REFERENCES:
1. Common Aviation Command and Control System Overview.
http://www.dote.osd.mil/pub/reports/FY2015/pdf/navy/2015cac2s.pdf

2. Air Command and Control and Sensor Netting Overview.
http://www.marcorsyscom.marines.mil/Portals/105/PELandSystem/AC2SN_090712.pdf

3. Non-Deterministic Policies in Markov Decision Processes; Fard and Pineau, 2011.
https://www.jair.org/media/3175/live-3175-5361-jair.pdf

4. Large Scale Deep Learning; Jeffrey Dean, 2014. http://research.google.com/pubs/pub43150.html

5. Facebook AI Research. https://research.facebook.com/ai

KEYWORDS: Artificial Intelligence; Decision Aid; Big Data; Machine Learning; Command and Control

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N162-075 TITLE: Small Unit Terrestrial Sensor Kit

TECHNOLOGY AREA(S): Battlespace, Electronics, Sensors

ACQUISITION PROGRAM: Tactical Remote Sensor System (TRSS)

OBJECTIVE: Develop a portable terrestrial sensor kit that is suited to the needs of small tactical units to assist in local area/perimeter security.

DESCRIPTION: Self-establishing networking technologies and miniaturized components are in common use for commercial and government applications. However, transitioning these technologies for use by small tactical units has not been forthcoming (Ref 3).

Small (Hockey Puck Size, weights of 500 grams or less) ruggedized (resin –encased) multimodal (Seismic/Acoustic) battery-operated (COIN sized batteries) sensors of a limited detection range (50 meters or less) combined with a smart-phone size controller/alarm device could satisfy this operational deficiency. These units operate under extremely stressful conditions, and their need for easy manipulation and configuration of these devices in darkness and daylight lends itself to many of the attributes encountered with smart-phone-user interfaces. The advent of multi-purpose tablet sized devices to the operating forces is beginning, and could serve as the basis for the Controller/Alarm platform. Up to 10 sensors shall be controlled by a control module.

Proposed concepts shall be capable of operation between 0-65 degrees Centigrade, with an operating life of 7 days (168 hours) before replacement/recharging of the power supply is required. Water immersion resistance requirements required is for no moisture penetration in 1 meter of water for 24 hours. Shock resistance requirements are for components to withstand a vertical drop of 5 meters onto a hard surface. Setup time requirements shall be less than 2 minutes threshold, 1 minute objective. Reliability requirements shall be 80% reliable for 168 hours with a threshold confidence factor of 80%, threshold 90%. Detection range of moving personnel threshold is 50 meters threshold, 75 meters objective.

The wireless control module shall have a display compatible with night vision devices, and possess both visual and vibration detection alerts, selectable as both, visual or vibration. The system shall have a self-establishing capability. The system shall have the ability to establish its own network upon activation.

PHASE I: The small business will define concepts and demonstrate the feasibility for the development of a Small Unit Terrestrial Sensor Kit and in meeting Marine Corps needs. The small business will further establish that the concepts can be developed into a useful product for the Marine Corps. Feasibility will be established by material testing, cost analysis, and analytical modeling, as appropriate. The small business will provide a Phase II development plan with performance goals and key technical milestones, and that will address technical risk reduction.

PHASE II: Based on the results of Phase I and the Phase II development plan, the small business will develop a scaled Small Unit Terrestrial Sensor Kit prototype for evaluation. The prototype will be evaluated to determine its capability in meeting the performance goals defined in the Phase II development plan and the Marine Corps requirements for the Small Sensors Kit. System performance will be demonstrated through prototype evaluation and modeling or analytical methods over the required range of parameters including numerous deployment cycles. Evaluation results will be used to refine the prototype into an initial design that will meet Marine Corps

requirements. The company will prepare a Phase III development plan to transition the technology to Marine Corps use.

PHASE III DUAL USE APPLICATIONS: If Phase II is successful, the company will be expected to support the Marine Corps in transitioning the Small Unit Terrestrial Sensor Kit for Marine Corps use. The company support the operational evaluation of the Small Sensor Kit to determine its effectiveness in an operationally relevant environment. The company will support the Marine Corps for test and validation to certify and qualify the system for Marine Corps use. Private Sector Commercial Potential: This effort has applicability to both commercial and government enterprises charged with providing sensor-based security solutions.

REFERENCES:
1. Headquarters Marine Corps Intelligence Plans Division Wargame Report", Persistent Warrior-Wargame Report August 2015. http://www.mcwl.marines.mil/Portals/34/Documents/EW13%20Final%20Report_FINAL.pdf

2. Lin, John, "Applications of ZigBee Technology", NIST, October 7, 2005; http://gsi.nist.gov/global/docs/mra/2005_Lin_ZigBee.pdf

3. Kaushik, B. Nance, Don, and Ahuja, K "A Review of the Role of Acoustic Sensors in the Modern Battlefield" 11th AIAA/CEAS Aeroacoustics Conference (26th AIAA Aeroacoustics Conference) 3 - 25 May 2005, Monterey, California. https://ccse.lbl.gov/people/kaushik/papers/AIAA_Monterey.pdf

KEYWORDS: Terrestrial Sensors; Multimodal Sensors; ruggedized; Controller/Alarm Function; Seismic/Acoustic; Sensor String

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N162-076 TITLE: Miniaturization of GPS Alternative Survey Equipment

TECHNOLOGY AREA(S): Battlespace, Electronics, Sensors

ACQUISITION PROGRAM: PM114, Armor & Fire Support (PM AFSS)

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 5.4.c.(8) of the solicitation. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop miniaturized inertial survey system which can meet the current IPADS performance requirements with significant reductions in form factor and weight. The system must support artillery missions by obtaining accurate Survey Control Points (SCPs) and to lay azimuths for indirect fire. In doing so, the IPADS

provides a common grid at the accuracies required to support indirect fire missions as opposed to standalone Global Positioning System (GPS) systems which provide an absolute GPS solution.

DESCRIPTION: The current IPADS system utilizes an inertial system supplemented by GPS for use when reception is available as an alternative to re-zeroing at a standstill. However, the current system is based on 10-15 year old inertial navigation sensor technology. While the current system can meet the survey requirement, it requires multiple Marines to lift and install based on the weight and size of the baseplate and IPADS frame. An innovative approach is sought in order to reduce the size and weight of the material solution (less than 30 pounds is desirable) to allow a single Marine to transport and install the system while maintaining system performance. In an effort to highlight technical challenges, it is most difficult to meet the current IPADS requirement that the system shall achieve azimuth accuracy of 0.4 mils Probable Error (PE) from 0 degrees to 65 degrees North or South latitude and 0.6 mils PE from 65 degrees to 75 degrees North or South latitude. Also the IPADS system must meet the threshold requirements in the performance specification without utilizing GPS.

PHASE I: Develop concepts for a miniaturized inertial survey system that meets the previously established IPADS requirements. Analysis (survey tolerance stack-up studies, for example) should clearly demonstrate a system approach where component development and integration will result in a high probability of achieving survey performance goals while allowing weight and size to enable a one Marine transport and installation. Phase I results will also include details on the hardware/software which will comprise the system to clearly illustrate the projected size/weight. Subsequently, Phase I will include a Phase II development plan to prototype and evaluate the system.

PHASE II: Based on the results of Phase I and the Phase II development plan, a prototype solution of the miniaturized survey system should be evaluated and compared against the current IPADS performance specification when installed in or transported by a vehicle. The company will prepare a Phase III development plan to transition the technology to Marine Corps use. The expected transition product is a TRL level 6 prototype miniaturized inertial survey system.

PHASE III DUAL USE APPLICATIONS: This effort will require completion of a production representative design that satisfies the performance, cost, logistical, and schedule goals of the IPADS replacement program. Private Sector Commercial Potential: Inertial based survey and navigation equipment and more specifically, the sensors to enable the capability have commercial applications for automotive use, survey equipment applications, autonomous navigation for manned and unmanned aircraft, ground vehicles, ships, and submersibles.

Many automotive systems rely on inertial sensors as one of several triggers to other systems. Additionally, survey capabilities in GPS limited environments rely on GPS base stations as a repeater where a highly accurate inertial system could supplant that technology if cost effective. Furthermore, navigation for aircraft can benefit in urban areas and other locations where GPS signals are unavailable or confounded by multipath.

REFERENCES:
1. Performance Specification, Improved Position and Azimuth Determining System (IPADS), MILPRF- 52955D, 7 April 2007.

2. USMC Organizational and Operational (O&O) Concept for the Improved Azimuth and Position Determining System (IPADS), 1 July 2003.

3. Operational Requirements Document (ORD) for the Improved Position and Azimuth Determining Systems (IPADS), 10 September 2006.

KEYWORDS: Survey, inertial, sensors, GPS, targeting, artillery, navigation

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N162-077 TITLE: Suppressor Cleaning Method

TECHNOLOGY AREA(S): Weapons

ACQUISITION PROGRAM: MARCORSYSCOM IWS PdM IW M40 Series Sniper Rifle

OBJECTIVE: The objective of this effort is to develop an effective method to remove carbon/metal fouling from permanently sealed, Quick Detach (QD) and direct thread-on suppressors. Current cleaning methods are often ineffective on permanently sealed suppressors. Proper cleaning would extend the service life of these items and eliminate unnecessary replacement costs.

DESCRIPTION: Due to operational tempo, suppressed weapons fire is becoming more common during everyday operations. More carbon/metal fouling accumulates in the firearm through suppressed fire than unsuppressed fire, which necessitates more frequent cleaning. Marine Corps issued suppressors are typically permanently-sealed, QD suppressors. Although these are easily removable from the barrel for cleaning, they are sealed units that cannot be disassembled into individual components to facilitate cleaning. Without the ability to properly clean sealed suppressors, these units are turned in as unserviceable before their lifetime. If a method to properly clean these suppressors were available, this would extend the service life of the item and eliminate unnecessary replacement costs. Proposed methods shall demonstrate superior cleaning performance to conventional methods.1, 2 In addition, proposed methods shall address facility impacts such as cost/savings benefits and the disposal of generated hazardous material.

PHASE I: The small business shall demonstrate the feasibility for the development of a suppressor cleaning system that meets the Marine Corps' needs. Feasibility shall be demonstrated through benchtop testing with a breadboard model.

PHASE II: The small business shall develop a prototype cleaning system with the capability to simultaneously clean multiple suppressors. The prototype shall be provided to the Marine Corp for testing and evaluation.

PHASE III DUAL USE APPLICATIONS: The small business shall support the Marine Corps in transitioning the suppressor cleaning system manufacture cleaning systems suitable for fleet use. The small business shall prepare a Facility Impact Report assessing costs, infrastructure requirements, maintenance, and disposal of hazardous material. At a minimum, cleaning systems would be made available to Intermediate Maintenance Activities (IMAs) where facility impacts are easier to manage. An initial quantity of 12 to 24 is projected for the IMAs. Suppressor cleaning systems are desired for use at the Organization Level where maintenance must be expeditious to ensure operational readiness. However, units at the Organization Level are more sensitive to facility impacts due limited resources. If the Facility impact at the Organizational Level is favorable, a quantity of 48 to 96 is projected in addition to those for the IMAs. Private Sector Commercial Potential: In addition to the DoD military market, this cleaning system would be applicable to state and local law enforcement, the Department of Homeland Security (i.e.; State Department, FBI, Secret Service and Coastguard) and the civilian sporting market.

REFERENCES:
1. Atkinson, B., "How to Clean a Firearm," SSAA National Media & Publications, accessed 19 February, 2016, https://www.ssaa.org.au/stories/hints-tips-how-to-clean-a-firearm.html.

2. Sweeny, P. “Should You Clean Suppressors,” Firearm New, March 2015, accessed 19 February, 2016, http://www.firearmsnews.com/gear-accessories/suppressors/clean-suppressors/.

3. Dater, P., “Sound Measurement Techniques,” Small Arms Review, V3#11, Aug 2000.

4. Dater, P., “Firearm Sound Levels and Hearing Damage, “Small Arms Review, V6#3, Dec 2000.

KEYWORDS: Small Arms; Sound Suppressor; Suppressor Maintenance; Noise Suppression; Suppressor Fouling; Quick-Detach and Thread-on Suppressors

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Questions may also be submitted through DoD SBIR/STTR SITIS website.

N162-078 TITLE: Adaptive Hull Structure

TECHNOLOGY AREA(S): Ground/Sea Vehicles

ACQUISITION PROGRAM: PM, Advanced Amphibious Assault

OBJECTIVE: The objective is the development of an innovative simple method of deployable/retractable hull modification allowing higher water speed movement of an amphibious vehicle.

DESCRIPTION: With the cancelation of the Expeditionary Fighting Vehicle (EFV) program there still exists within the Marine Corps the need for a high water speed amphibious vehicle. For a vehicle to travel at higher speeds in the water it must be capable of planing or use some other method to reduce drag on the vehicle structure (example hydrofoil). Hydrodynamic drag from the vehicle shape is the major cause driving the size of the engine powering the vehicle and fuel consumption while waterborne. Current state of the art of a hard adaptive hull structure for an amphibious vehicle was developed for use on the EFV program. When deployed, the adaptive hull structure allowed the EFV (a vehicle of dimensions 30 ft. long, 12 ft. wide, 10.5 ft. high and weight 80,000 lb.) to attain a water speed of 25 knot. The system consisted of a retractable suspension, deployable bow and transom extension and chines. This system increased the flat plate planing surface allowing the vehicle to attain high water speed movement. Although functional, it employed a complex high pressure hydraulic system for deployment and retraction of the suspension which resulted in one of the most costly systems on the vehicle. One other available state of the art system capable of supporting an amphibious vehicle is pontoons. These devices are used on a variety of vehicles and take the form of fixed or inflatable devices. Currently deployable pontoons are used on the Korean K21 IFV. The pontoons are stowed in the skirt on either side of the vehicle and inflated when amphibious operations are required. After water operations the pontoons are deflated and retracted into the skirt. Although suitable for low speed movement in their current configuration they are not suited for higher speed water mobility.

Other state of the art technology includes semi rigid structures which utilize a fixed or inflatable planning hull that does not interfere with water jet performance and may allow leaving the tracks/wheels in-place thus reducing overall vehicle complexity/cost. By utilizing one or some combination of the available technologies a suitable adaptive hull structure for supporting a vehicle of dimensions 30 ft. long, 12 ft. wide, 10.5 ft. high and weight 80,000 lb. is sought.

PHASE I: The small business will develop concepts for an adaptive hull structure that meets the requirements described above. The small business will demonstrate the feasibility of the concepts in meeting Marine Corps needs and will establish that the concepts can be developed into a useful product for the Marine Corps. Feasibility will be established by material testing and analytical modeling, as appropriate. The small business will provide a Phase II development plan with performance goals and key technical milestones, and that will address technical risk reduction.

PHASE II: Based on the results of Phase I and the Phase II development plan, the small business will develop a scaled adaptive hull structure prototype for evaluation. The prototype will be evaluated to determine its capability in meeting the performance goals defined in the Phase II development plan and the Marine Corps requirements for the adaptive hull structure. System performance will be demonstrated through prototype evaluation, modeling and simulation and analysis over the required range of parameters throughout the deployment cycle. Evaluation results will be used to refine the prototype into an initial design that will meet Marine Corps requirements. The small business will prepare a Phase III development plan to transition the technology to Marine Corps use.

PHASE III DUAL USE APPLICATIONS: If Phase II is successful, the company will be expected to support the Marine Corps in transitioning the technology for Marine Corps use. The company will manufacture a full scale adaptive hull structure for evaluation to determine its effectiveness in an operationally relevant environment. The company will support the Marine Corps for test and validation to certify and qualify the system for Marine Corps use. Private Sector Commercial Potential: The potential for commercial application of an adaptive hull structure has many potential uses. Possible avenues for employment are fire rescue and law enforcement vehicles, recreational vehicles (personal amphibious water craft) and wild life management vehicles to name a few.

REFERENCES:
1. Expeditionary Fighting Vehicle (EFV) – Specification.
http://www.globalsecurity.org/military/systems/ground/aaav-specs.htm

2. K-21 Infantry Fighting Vehicle. http://www.military-today.com/apc/nifv.htm

3. Zodiac. http://www.zodiacmarineusa.com/

4. Rigid-hulled inflatable boat. https://en.wikipedia.org/wiki/Rigid-hulled_inflatable_boat

KEYWORDS: Hull; High Water Speed; Adaptive; Plaining; Ground Vehicle; Amphibious

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N162-079 TITLE: Fuel Efficiency Improvements for Amphibious Vehicles

TECHNOLOGY AREA(S): Ground/Sea Vehicles

ACQUISITION PROGRAM: PM, Advanced Amphibious Assault

OBJECTIVE: The objective is the development of innovative technologies that reduce fuel consumption enabling longer mission durations and/or increased operating ranges for an Amphibious Combat Vehicle (ACV) 1.1 vehicle.

DESCRIPTION: The Amphibious Combat Vehicle Phase 1 Increment 1 (ACV 1.1) is an armored personnel carrier that is balanced between performance, protection, and payload for employment within the Ground Combat Element (GCE) and throughout the range of military operations, to include a swim capability. Amphibious vehicles operate on the leading edge of an assault and in austere environments where logistics support including access to fuel is limited. PM Advanced Amphibious Assault (AAA) is looking for technologies that reduce fuel consumption and thus enable longer mission durations and increased operating ranges for ACV 1.1. The automotive industry has done a lot of work improving fuel efficiency. However, ACV 1.1 is significantly heavier than most commercial applications, must operate in water, off-road and idles a significant amount of time. The ACV 1.1 is a Modified Non Development Item that has a traditional diesel engine powertrain. The engine operates at two different load levels. First, the engine must operate at high-power to climb slopes, traverse soft soils and operate in a wide range of amphibious conditions. Second, the engine must operate for long periods of time at a low capacity while the vehicle is parked to support generation of electricity and HVAC functions. Technologies that can efficiently adapt to varying load and terrain requirements as dictated during the performance of its mission could result in significant fuel savings. Other technologies, like electrification of engine accessories, have been investigated to improve fuel efficiency for similar powertrains on commercial and military vehicles. Technologies that reduce weight, particularly un-sprung mass, can improve fuel efficiency while also improving ride quality and water performance. By using a combination of the available technologies, a significant increase in operating time and range could be achieved.

The goal for this program is to reduce fuel usage over the ACV mission profile by 10 to 15%. The ACV will operate on land for more than 95% of its mission and average over 60% of its time at idle, under low load or on silent watch. While the vehicles spend a significant amount of time at idle and silent watch, the majority of its fuel usage is expected while the vehicle is moving. The land operating profile is expected to consist of 10% Primary Roads, 20% Secondary Roads, 30% Trails and 40% Cross Country.

The ACV 1.1 will begin Full Rate Production in 2019, but ACV production will continue for over 20 years. ACV 1.1 will be followed by ACV 1.2 followed by either ACV 1.3 or ACV 2.0. There will be opportunities for Engineering Change Proposals (ECP's) to fielded vehicles as well as opportunities to cut new technologies into the production line over that 20-year period.

PHASE I: The small business will develop concepts for fuel efficiency improvements including an estimate of reduced consumption/increased operation time and/or distance for an ACV 1.1 notional vehicle. The small business will demonstrate the feasibility of the concepts in meeting Marine Corps needs and will establish that the concepts can be developed into a useful product for the Marine Corps. Feasibility will be established by material testing and analytical modeling, as appropriate. The small business will be encouraged to work with the ACV Prime Contractors but this may not be necessary in Phase I depending on the technology and how it would be integrated on the platform. The small business will provide a Phase II development plan with performance goals and key technical milestones that will address technical risk reduction.

PHASE II: Based on the results of Phase I and the Phase II development plan, the small business will develop a scaled prototype for ACV fuel efficiency improvements for evaluation. The fuel efficiency improvements prototype will be evaluated to determine its capability in meeting the performance goals defined in the Phase II development plan and the Marine Corps requirements for fuel efficiency improvements. System performance will be demonstrated through prototype evaluation, modeling and simulation and analysis over the required range of parameters based on the component/concept selected. Evaluation results will be used to refine the fuel efficiency improvements prototype into an initial design that will meet Marine Corps requirements. The company will prepare a Phase III development plan to transition the technology to Marine Corps use.

PHASE III DUAL USE APPLICATIONS: The small business will develop a full scale modification package for evaluation on the ACV to determine its effectiveness in an operationally relevant environment. The company will support the Marine Corps for test and validation to certify and qualify the system for Marine Corps use. The small business will work with the ACV program office to develop an engineering change proposal to be applied to fielded

systems and/or applied to ACV's during subsequent vehicle production. Private Sector Commercial Potential: The potential for commercial application of the fuel efficiency technologies developed under this effort will have many potential transition paths. Possible avenues for employment are heavy construction equipment, fire, rescue and law enforcement vehicles, and recreational vehicles (personal amphibious water craft) to name a few.

REFERENCES:
1. ACV 1.1 Request For Information.
https://www.fbo.gov/index?s=opportunity&mode=form&tab=core&id=99a63e69459e1c60885a68674a3ba64e&_cview=0

2. Butcher, J., Vasavada, N., Bayer, J., Koplin, M. et al., "Optimizing the University of Wisconsin's Parallel Hybrid-Electric Aluminum Intensive Vehicle," SAE Technical Paper 2000-01-0593, 2000, doi: 10.4271/2000-01-0593.

3. Tai, C., Tsao, T., Schörn, N., and Levin, M., "Increasing Torque Output from a Turbodiesel with Camless Valvetrain," SAE Technical Paper 2002-01-1108, 2002, doi: 10.4271/2002-01-1108.

KEYWORDS: Fuel efficiency; Smart vehicle Technology; Ground Vehicle; Amphibious; Amphibious Combat

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Questions may also be submitted through DoD SBIR/STTR SITIS website.

N162-080 TITLE: Optically Based Small Arms Force-On-Force Training System

TECHNOLOGY AREA(S): Human Systems

ACQUISITION PROGRAM: Program: Force-on-Force PM: PM-TRASYS

OBJECTIVE: Develop Optically Based Small Arms Force-On-Force Training System (OBSAT) for live, force-on-force engagement that provides an alternative to laser-based engagement systems.

DESCRIPTION: The Marine Corps seeks to enhance "home station unit training through the sustainment and enhancement of live, virtual, and constructive training capabilities." Specifically, the Marine Corps seeks to "leverage modern immersive training and simulation technologies in order to ensure that Marines first encounter their tactical and ethical dilemmas in a simulated battlefield vice actual combat" [2]. This topic addresses Marine Corps' need for the development and maturation of alternative technologies to laser engagement systems for live, force-on-force training. Stuster and Coffman [1] showed that there is a significant reduction in unit casualties after the first five firefights. A major contributing factor to the higher casualty rates in those first five firefights was improper use of cover and concealment. The shortcomings in laser engagement systems provide negative training that results in improper use of cover and concealment in combat. Lasers are blocked by obstacles that provide only concealment in the real world but also appear to provide cover in training using Instrumented-Tactical Engagement Simulation System (I-TESS) or other laser engagement systems. Addressing this shortcoming, then, has the potential to reduce Marine casualties in their initial firefights. In addition, with laser engagement systems, basic rifle marksmanship skills are not reinforced, such as leading moving targets and adjusting barrel elevation based on target range. In fact, laser engagement systems reinforce bad habits in these areas. Finally, a major weapon system in the

infantry squad is the M-203 grenade launcher. The grenadier cannot practice employment of this key squad weapon during force on-force training, and squad and platoon leaders cannot train on the tactical employment of these systems. The Marine Corps seeks a technology that makes minimal use of appended equipment, such as I-TESS harnesses and halos, to support live training. The Marine Corps envisions a system that calculates the trajectory of the munitions and determines a hit or miss against stationary, moving, and partially occluded targets at realistic ranges and does not require appended lasers. Ideally such a system would use the day or night scope that is (or will be) part of a front-line Marine's go-to-war kit.

All proposed systems must accomplish the following objectives (a) determining the accuracy/effectiveness of weapons engagement by individual marines using squad/platoon level weapons, (b) providing accurate and immediate feedback to the marine targeted, and (c) utilizing a system that can differentiate between concealment and cover (protection) from weapons engagement will be considered. In addition, the Marine Corps seeks an alternative technology to laser based systems that meet the following parameters:
- Enables Marines to engage in force-on-force events at ranges of at least 375 meters, and preferably longer.
- Enables Marines to engage targets that are partially occluded by foliage and vegetation during force-on-force training.
- Computes real-time casualty assessment in force-on-force training in daylight, night, and in the presence of obscurants.
- Requires Marines to lead moving targets.
- Requires Marines to raise or lower the barrel of the rifle based on target range (the "bullet" travels in a realistic parabolic path, rather than a straight line).
- Enables Marines to use their organic squad weapons (threshold: semi-auto rifle and grenade launcher; objective: burst fire and automatic weapons).
- Makes minimum use of appended equipment.
- Uses munitions trajectory and damage assessment models similar to those used by virtual and constructive simulations, allowing for LVC interoperability.

Ideally this technology is equally applicable to vehicular combat as well as infantry combat.

One possible concept of how an OBSAT might work is to use a client-server approach similar to the current laser-based system. A main server performs combat adjudication, determining if a shot hits and the severity of the hit by having a real-time understanding of where every Marine (client) is within the training area. To maintain this awareness each Marine is instrumented with a GPS and inertial sensor via a Marine-Worn computing device (similar to a smart phone) that constantly updates the server on the location of the Marine. Besides the computing device the Marine is also equipped with a special optic on their weapon and a weapon orientation device. When a Marine pulls the trigger the system detects that a shot has been fired (similar to the way the current laser based force on force system works) and the following events occur:
(1) The Marine's site picture and weapon orientation are sent to the server via the computing device.
(2) Using the provided information the server determines if the target in the site picture was hit, where and how badly.
(3) If the server determines that the target has been hit it informs the targets computing device that the Marine has been hit and the severity. The targeted Marine receives an audible cue informing him that he has been hit.
Proposals based on different concepts or approaches that are capable of meeting all required objectives and performance parameters will be considered.

The Phase I Option, if awarded, should include the processing and submission of all required human subjects use protocols, if required. Due to long review times involved, human subject research is strongly discouraged during Phase I base, but may be appropriate for the option.

PHASE I: Demonstrate the technical feasibility for the development of an Optically Based Small Arms Force-On-Force Training System that addresses the current shortcomings of laser-based systems and meets many or all of the desired additional capabilities discussed in the Description section. The feasibility demonstration must work with an M-16, M-4, or acceptable surrogate at ranges of 150, 250, and 375 meters. The Phase I effort may involve appended equipment if there is a clear technology path to significantly reduce use of appended equipment as the technology matures.

PHASE II: Based on the Phase I effort, the small business will fully develop a prototype Optically Based Small Arms Force-On-Force Training System (OBSAT). This prototype system must demonstrate reduced need for appended equipment through the use of equipment that is in the fielding pipeline. The small business will also develop the engagement system technology to integrate with a real Thermal Weapon Scope (to be provided for this effort by the Government as GFE). The small business will also improve overall system latency and increase the number of supportable simultaneous trainees. Although the demonstration will be done with approximately 30 systems (2 marine squads) the Small Business must show that the fundamental underpinnings of the technology (e.g., bandwidth and computing power) are able to support over 1,000 participants. The small business must integrate their system with real M-4 rifles which will be firing blanks during the demonstration. The small business will also expand the demonstration of capability by adding one or more of the following: increased ranges, burst fire, automatic fire, and/or 40mm grenades. The result of Phase II will validate whether the prototype system is suitable and effective for live, force-on-force training in preparation for transition to Phase III.

PHASE III DUAL USE APPLICATIONS: The final result of Phase III is to mature existing technology to at least TRL 6 ready to transition to a PM TRASYS program of record to eventually replace I-TESS systems for Marine live, force-on-force training. Phase III seeks to expand demonstrated prototype Phase II capabilities in a number of directions: expanding to other infantry weapon systems (e.g., machineguns), improving technology readiness level (TRL) and preparing for integration, improving accuracy and robustness, supporting vehicular combat, etc. During Phase III the small business will integrate this technology into operationally representative training events. The small business will also integrate this technology with other live, virtual, and constructive training systems. Demonstration of the applicability of this technology to testing, concept development, and even commercial applications is encouraged. Private Sector Commercial Potential: The optically based technology has applicability in the entertainment industry. This technology, once mature, could replace paintball and laser tag. Since there are no projectiles, like paintballs, it would eliminate the need for special protective equipment, replacing ammunition, and cleanup. Since no lasers are used, the system is inherently eye safe.

REFERENCES:
1. Jack Stuster and Zail Coffman, Capturing Insights From Firefights To Improve Training, Phase Final Report, Sponsored by ¬Defense Advanced Research Projects Agency, ARPA Order: AT64-00, PAN RTW 2W-09, Issued by¬ United States Army Aviation & Missile Command Redstone Arsenal, AL 35898-5280, Contract Number: W31P4Q-09-C-0160, 31 January 2010, ANACAPA SCIENCES, INC., P.O. Box 519¬ Santa Barbara, California 93102.

2. Marine Corps Combat Development Command, Force Development Strategic Plan, 15 October 2015.

3. Marine Corps Combat Development Command, U.S. Marine Corps S&T Strategic Plan, 17 Jan 2015.

KEYWORDS: Force-on-force training, laser engagement systems, after action review, live-virtual-constructive

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Questions may also be submitted through DoD SBIR/STTR SITIS website.

N162-081 TITLE: Expeditionary Medical Refrigeration Unit

TECHNOLOGY AREA(S): Biomedical

ACQUISITION PROGRAM: MARCORSYSCOM, Program Manager Combat Support Systems, Battalion Aid Station (BAS) – AMAL 635

OBJECTIVE: The objective is to develop an innovative, energy efficient, small human transportable field refrigeration unit for field medical operations. The unit will be used to keep temperature sensitive human blood products, vaccines, and reagents within an optimum temperature range to ensure long term viability.

DESCRIPTION: Navy Medical Corpsmen, Nurses, and Doctors make frequent use of human blood products for resuscitative medical interventions, administer vaccines to Marines or civilians, and conduct medical assays for detection of illness or other medical conditions. All of these medically important consumable products must be kept within an optimum range of temperatures to prevent spoilage or damage to the active proteins within them. Vaccines and assays in particular are subject to irreversible damage from freezing and must be protected from subfreezing temperatures as well as well as from high temperatures. Currently the Navy fields a medical refrigeration system that is energy inefficient and has only two settings: a Refrigerator mode of +4°C (39.2°F) and a Freezer mode of -22°C (-7.6°F), making it difficult to maintain the specific temperature ranges required for certain vaccines and reagents and doing little to protect frost-sensitive products. To achieve this capability, the Expeditionary Medical Refrigeration Unit shall be able to maintain a user defined internal temperature to within -0, +2°C (-0, +3°F) of set point throughout an ambient operating temperature range of -32 – 52°C (-25 – 125°F) in a tactical environment (Role 1 to Role 2, primarily the Battalion Aid Station (BAS), Shock Trauma Platoon (STP), Forward Resuscitative Surgical Suite (FRSS) and Laboratory Equipment AMALs). The range of selectable internal temperatures shall be between -35°C and 25°C (-31°F – 77°F) Threshold; between -65°C and 25°C (-80°F – 77°F) Objective. The unit shall have minimum net capacity (output) of 30 watts thermal (102 Btu/hr) at a thermostat setting of 8°C and 40 watts thermal (136 Btu/hr) at a thermostat setting of 2°C (at 25°C ambient temperature). To protect frost-sensitive medical products such as vaccines from extreme cold the unit shall include an auxiliary heating capacity of not less than 30 watts thermal (102 Btu/hr). The unit shall have an internal payload volume of no less than 56.6 liters (2 ft3) with no internal payload dimension less than 33.0 cm (13 in), external dimensions not to exceed 100 cm (39.5 in) in any dimension, and a tare weight not to exceed 66 kg (145 lb). The device must support USMC energy efficiency goals by operating from a self-contained power source (such as batteries) for up to 24 hours Threshold; 48 hours Objective and shall utilize standard USMC field power for both direct power and battery recharging (110/220 VAC and 12-32 VDC). Designing for energy efficiency and minimal power consumption will be a primary objective of this program. The device must conform to MIL-STD-810G for environmental readiness, including storage at temperatures of -25 to 160 degrees F and operation at temperatures of -25 to 130 degrees F, the ability to withstand transport shock and vibration, ability to withstand operational drop of 36 inches and storage drop of 48 inches, ability to withstand settling sand and dust and blowing rain, and ability to operate at altitudes of up to 10,000 feet. The device shall be capable of achieving FDA 510(k) clearance for medical devices with submission for 510(k) being a key performance parameter of this device. Devices must be fully self-contained and designed for organic supportability by qualified active duty biomedical engineering technicians.

PHASE I: The small business will develop concepts for an Expeditionary Medical Refrigeration Unit that meets the requirements discussed in the Description section. The small business will demonstrate the feasibility of the concepts in meeting Marine Corps needs and will establish that the concepts can be developed into a useful product for the Marine Corps. Feasibility will be established by material testing, as appropriate. The small business will provide a Phase II development plan with performance goals and key technical milestones, and that will address technical risk reduction.

PHASE II: Based on the results of Phase I and the Phase II development plan, the small business will develop an initial Expeditionary Medical Refrigeration Unit prototype for evaluation. The prototype will be evaluated to determine its capability in meeting the performance goals defined in the Phase II development plan and the Marine Corps requirements for the Expeditionary Medical Refrigeration Unit. System performance will be demonstrated through prototype evaluation over the required range of parameters including numerous deployment cycles. Evaluation results will be used to refine the prototype into an initial design that will meet Marine Corps requirements. The small business will prepare a submission package for FDA 510(k) clearance with the assistance of and sponsorship by the Marine Corps. The small business will prepare a Phase III development plan to transition the

technology for commercial and Marine Corps use.

PHASE III DUAL USE APPLICATIONS: If Phase II is successful, the company will be expected to support the Marine Corps in transitioning the technology for Marine Corps use. The company will deliver the Expeditionary Medical Refrigeration Unit for evaluation to determine its effectiveness in an operationally relevant environment. The company will achieve FDA 510(k) clearance for the device and will support the Marine Corps for verification testing and validation to certify and qualify the system for Marine Corps use. The company will support the Marine Corps in the training of users and maintainers and the development of commercial users' and maintainers' manuals. Private Sector Commercial Potential: The Expeditionary Medical Refrigeration Unit will be an FDA 510(k) certified commercial medical device that can be used in civil and industrial medical use. Potential private sector users include hospitals, clinics, paramedics/EMTs, search and rescue teams, disaster relief organizations, and other industries where medical grade products must be kept at a precise temperature.

REFERENCES:
1. UL 471, Standard for Commercial Refrigerators and Freezers. http://ulstandards.ul.com/standard/?id=471_10

2. Solar-Powered Refrigeration System, NASA Johnson Space Center.
https://www.nasa.gov/centers/johnson/techtransfer/technology/MSC-22970-1_Solar-Refrigerator-TOP.html

3. Operating Instruction Two-Temperature Hemacool, Advanced Technology Blood Product Storage and Transport Refrigerator/Freezer Model HMC-MIL-1 of May 2005.
http://www.steelsoldiers.com/upload/misc/HemaCool_Operations_5_13_05.pdf

4. Code of Federal Regulations Title 21, Part 640, of 1 Apr 2015.
http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfCFR/CFRSearch.cfm?CFRPart=640

5. Department of Defense. MIL-STD-810G, Department of Defense Test Method Standard: Environmental Engineering Considerations and Laboratory Tests. 31 Oct 2008. http://www.atec.army.mil/publications/Mil-Std-810G/Mil-std-810G.pdf

KEYWORDS: Medical refrigeration, medical devices, blood products, vaccines, immunizations, medical

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Questions may also be submitted through DoD SBIR/STTR SITIS website.

N162-082 TITLE: Analog to Information Processing

TECHNOLOGY AREA(S): Electronics, Sensors

ACQUISITION PROGRAM: PMA-290 Maritime Surveillance Aircraft

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual

use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 5.4.c.(8) of the solicitation. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop an analog to information processing approach to bypass Analog-to-Digital Converter (ADC) that is capable of lower power consumption, smaller circuit size and does not require upfront digitization.

DESCRIPTION: The current all-digital processing approach puts the Analog-to-Digital Converter (ADC) and Digital-to-Analog Converter (DAC) as close as possible to the sensors and actuators (antenna, pixels, etc.). This approach has been driven by transistor scaling and programming flexibility. Current performance issues include constraints from power consumption, ADC/DAC requirements, and size. While requirements are application specific, current technologies are constrained by the needed physical size, power consumption, resolution, speed and in some case their cost. Performance of present ADCs generally prohibit the direct digitization of wide bandwidth and high dynamic range RF signals; for example, a 10 GHz bandwidth state-of-the art ADC can provide only 5-bit resolution, while near-term next generation receiver systems would require over 10-bit resolution in the same bandwidth. Based on current trends, this would take approximately 30 years to achieve.

The desired innovation is the development of an analog-to-feature converter (AFC) approach that will enable direct conversion of challenging wideband and high dynamic range RF signals to information directly. From a top level functional perspective the AFC should encode the RF/analog input signal to enable a more robust analog representation, i.e., asynchronous pulse domain (continuous-time digital), and to enable implementing general discrete-time/continuous time linear/nonlinear time-frequency filters, delay circuits, and nonlinear processors in the asynchronous pulse domain. The signal path should be split into two after the encoding circuit. The upper path would be used to generate a 1-bit time-frequency map of the input signal using Cohen-class transforms. This map is then optionally delivered to the signal projection unit, analog pre-processing unit, and/or digital post-processing unit, depending upon the tasks the AFC is performing. The key advantages of such an approach is that the analog information to be digitized is highly compressed, and as a result, the AFC requires a much smaller number of ADCs than conventional Nyquist sampling and channelization-based receivers. The key innovation being sought is an implementation approach that accomplishes these functions while significantly reducing the needed size, weight and power required as compared to conventional ADC/DAC approaches. We seek to reduce the computational load on the digital signal processors by an order of magnitude by analog pre-processing of input signal and information and achieve a 10-15 percent reduction in sensor electrical power usage.

PHASE I: Detail and demonstrate the feasibility and approach through high fidelity simulations. Develop concepts for hardware design and fabrication and provide a means to evaluate the technical feasibility.

PHASE II: Based on Phase I effort, further develop designs for a prototype AFC system. Demonstrate performance with respect to wideband radio frequency applications (radar and electronic support measures (ESM)). Describe in detail the system architecture including estimated cost to fully mature this technology and manufacturing approaches.

PHASE III DUAL USE APPLICATIONS: Finalize the AFC design and produce a production representative device suitable for use in a next generation maritime surveillance radar and/or ESM system on Navy aircraft. Private Sector Commercial Potential: Commercial data and video systems will be enabled with this technology.

REFERENCES:
1. Unser, M., (2000). Sampling 50 Years After Shannon. Proceedings of the IEEE, Vol. 88, No. 4, p. 569-587. http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=843002

2. Vaidyanathan, P., (2001). Generalizations of the Sampling Theorem: Seven Decades After Nyquist. IEEE Transactions on Circuit and Systems, Vol. 48, No. 9, 2001, p. 1094-1108. http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=948437

3. Donoho, D. and Logan, B., (1992). Signal Recovery and the Large Sieve. SIAM Journal of Applied Math, Vol. 52, p. 577-591. http://epubs.siam.org/doi/abs/10.1137/0152031

4. Auger, F. and Hlawatsch, F. (2006). Time-frequency Analysis: Concepts and Tools. p 131-151. www.iste.co.uk/data/doc_kmwlrnocsxjk.pdf

KEYWORDS: Radar; Analog-to-Digital Converter; Digital-to-Analog Converter; Analog-to-Feature Converter; Information Processing; Sampling Theory

TPOC-1: 301-904-4742

TPOC-2: 301-342-9094

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N162-083 TITLE: Rapid, Low Cost, High-quality Component Qualification Using Multi-scale, Multi-physics Analytical Toolset for the Optimization of Metal Additive Manufacturing Process Parameters

TECHNOLOGY AREA(S): Air Platform, Materials/Processes

ACQUISITION PROGRAM: 4.0T - CTO, Chief Technology Office

OBJECTIVE: Develop an innovative multi-scale, multi-physics, analytical software toolset capable of optimizing critical metal laser powder bed additive manufacturing (AM) process parameters to enable rapid, low cost, high-quality component qualification.

DESCRIPTION: As metal additive manufacturing (AM) continues to progress, several Navy programs are looking to take advantage of the design freedom and as-needed production capability the technology has to offer. However, AM part quality is negatively impacted by process variability between AM methods, machines, materials, and build environments. These differences, combined with the cyclic nature of the AM process itself (heating and cooling / expanding and contracting,) often result in parts that do not meet design specifications. The primary method of addressing these issues has been to adjust process parameters through trial and error. However, this costly and time consuming approach may still not provide the best parameter combination. Simulations have been developed to try to predict the effects these influences will have on part quality, but they are limited in their abilities. In most cases these simulations consider the effects of only one of these influences and do not take into account the interactions of the others. These simulations also tend to focus on either a part's micro or macro structure, which prevents them from being able to fully optimize process parameters for both.

In order to quickly and cost-effectively produce and qualify high-quality AM parts, an innovative prediction and optimization software toolset is sought. The software toolset will need to consider the thermal and mechanical aspects of the AM process and the variables introduced by the selected AM machine, material and build environment for both the micro and macro structure levels. Ideally, this toolset will take user defined and/or previously loaded input parameters for the selected AM machine (e.g. energy, scan speed, scan spacing, and layer height ranges as well as possible support strategies, scan patterns, and build environment conditions), fabrication material (e.g. particle size and shape, packing density, and conduction), and desired part qualities. From these inputs, the toolset will be able to provide the user with a list of machine settings necessary to achieve the desired part qualities such as: surface finish; dimensional tolerances; specified microstructure; necessary performance characteristics (e.g. strength and fatigue); and minimized distortion and porosity.

PHASE I: Demonstrate feasibility of an integrated analytical software toolset capable of predicting key part qualities and providing optimized machine process parameters to ensure a quality part (i.e. a part that has the desired surface finish and dimensional tolerances; minimum distortion, residual stress, and porosity; and the necessary microstructure to achieve the required mechanical and fatigue characteristics) by comparing predictions and a limited set of specimens using a single laser powder bed machine and single material (e.g. Ti64 or 17-4PH.)

PHASE II: Develop a prototype of the software toolset using the framework developed in Phase I to optimize process parameters to achieve desired part qualities, as well as provide a prediction of these features for a part produced using build parameters that have been optimized for production (i.e. minimal support structure, powder use, necessary post processing, etc.). Demonstrate and validate the prototype by comparing the optimized builds and predictions to baseline builds (i.e. using default process settings) and traditional build characteristics (part geometry, strength and fatigue properties) of desired Navy components from a number of Navy-selected laser powder bed machines and materials.

PHASE III DUAL USE APPLICATIONS: Fully develop the prototype toolset into a release version of the software to enable integration into Navy and Commercial AM software applications. Private Sector Commercial Potential: The design freedom and potential time and cost savings of additive manufacturing (AM) make it applicable to almost any industry. However, in most cases, industries do not have a good understanding of the AM build process. This leads to millions of dollars being wasted on inefficient attempts to address build problems and wasted material on unusable parts. The proposed prediction/optimization toolset would provide industry with an effective means of minimizing residual stress and distortion before the build process is even started and would reduce the need for highly trained operators.

REFERENCES:
1. Neugebauer F., Keller N., Ploshikhin V.; Feuerhahn F., & Köhler H., (2014). Multi Scale FEM Simulation for Distortion Calculation in Additive Manufacturing of Hardening Stainless Steel. International Workshop on Thermal Forming and Welding Distortion, Bremen, 09-10 April, 2014
http://www.researchgate.net/publication/266652527_Multi_Scale_FEM_Simulation_for_Distortion_Calculation_in_Additive_Manufacturing_of_Hardening_Stainless_Steel

2. Sun, J., Yang, Y., & Wang, D. (2013). Parametric optimization of selective laser melting for forming Ti6Al4Vsamples by Taguchi method. Optics & Laser Technology 49: 118-124. 23 January 2013.
http://www.sciencedirect.com/science/article/pii/S0030399212005531

3. Keller, N., Neugebauer, F., Xu, H., & Ploshikhin, V. Thermo-mechanical Simulation of Additive Layer Manufacturing of Titanium Aerospace structures. http://www.dgm.de/download/tg/1171/1171-160.pdf

KEYWORDS: Cost Reduction; multi-scale; Metal Additive Manufacturing; Process Optimization; Multi-physics; Part Quality

TPOC-1: 301-342-8511

TPOC-2: 301-757-1832

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N162-084 TITLE: Hardware Open Systems Technologies (HOST) Hardware Integration Tool Set

TECHNOLOGY AREA(S): Air Platform, Electronics, Information Systems

ACQUISITION PROGRAM: Joint Strike Fighter F-35 Lightning II Program

OBJECTIVE: The Navy is seeking an innovative tool set solution for the integration of Hardware Open Standards Technologies (HOST) conformant components which will aid in component selection and component integration such that system requirements can be met at a reduced cost.

DESCRIPTION: Hardware Open Systems Technologies (HOST) is an Open Systems Architecture (OSA) which defines virtual and physical interfaces to hardware such that interoperability and reuse of hardware components can be realized. The HOST standards leverage commercial technology combined with form factor such as the VITA Standards Organization's OpenVPX 6U standard [4, 5, 6]. The OpenVPX standard is flexible enough to allow vendor lock to occur. HOST constrains the use of the OpenVPX standard, thus preventing the opportunity for vendor lock to occur. The intent of HOST is to establish performance and interface requirements that are open, enforceable, and testable. As diminishing supplies and obsolescence become more impactful, HOST will facilitate addressing obsolescence and diminishing supplies as well as capability growth from new and/or evolving requirements.

Currently, the system integration effort is unique for each platform and labor intensive. HOST will enable a market where platforms can acquire hardware from multiple different vendors over the life of the system further complicating embedded system integration. As HOST is a new standard, no tooling currently exists to assist with easing or automating the integration of HOST components. Consequently, innovation is required to develop a set of tools (both physical and logical) to support mission computer and / or embedded processing system integration.

The purpose of this solicitation is to develop tools which can support the integration of HOST conforming hardware components. At a minimum the tool sets should be capable of modeling the following:
1. logical interfaces
2. environmental and mechanical performance
3. load distribution
4. hardware component and system level configuration

Additional modeling areas of consideration may include in rank order priority:
1. Built in Test (BIT)
2. firmware integration
3. error handling and reporting
4. debugging
5. alleviating performance bottlenecks and hardware optimization
6. power analysis
7. boot optimization

Tools should help systems integrators with hardware selection and provide output which integrators can use for the physical and logical integration. Modeling and simulation-driven development of embedded real-time systems published in the Simulation Modeling Practice and Theory Journal [3] articulates some of the complexities associated to the integration of embedded systems and may provide additional insight. Note that this journal entry ties the framework and tool to a specific real-time operating system, this is not within the scope of HOST. Instead, the Navy is seeking a tool that specifically addresses the HOST profiled OpenVPX 6U and 3U hardware and system software excluding any specific operating system.

PHASE I: Develop and demonstrate concept feasibility for a Hardware Open Systems Technologies (HOST) Hardware Integration Tool Set. Phase I will result in the identification of tool(s) with capabilities and methodologies for facilitating interoperable hardware integrations to meet the minimum and to the extent practicable additional modeling considerations identified in the above Description. The developed capabilities and methodologies will provide the basis for tool design and prototype build efforts during Phase II.

PHASE II: Design, build and demonstrate a prototype (HOST) Hardware Integration Tool Set which meets the objectives outlined in the "Objective" and "Description" sections above. This prototype will be based on the

capabilities and methodologies identified for the HOST Hardware Integration Tool Set developed in Phase I.

PHASE III DUAL USE APPLICATIONS: Finalize and transition tool(s) and techniques for HOST hardware integration. During this process, finalize the resultant prototype tool(s) for broader market utilization in both military and commercial applications. Private Sector Commercial Potential: Manufacturers developing hardware for embedded systems and seeking to conform to the HOST standard will benefit from this / these integration tool(s). These integration tools will help to create a market ecosystem which will enable small businesses to more quickly test and incorporate new capabilities that can be provided more rapidly to the warfighter in "bite sized", cost effective elements similar to the way in which the commercial smart phone market allows even individuals to sell new apps like "Angry Birds" to everyday smart phone users. These embedded systems span much further than just naval aviation and could be utilized within the FAA and control systems ranging from trains to nuclear reactors. In all cases, these systems have to be integrated in order to work correctly. The tools developed under this effort clearly have potential benefit to these commercial needs.

REFERENCES:
1. Hardware Open Systems Technology – Tier 1 Version 1.0. (Uploaded in SITIS on 4/22/16.)

2. Hardware Open Systems Technology – Tier 2 Version 1.0. (Uploaded in SITIS on 4/22/16.)

3. Modeling and simulation-driven development of embedded real-time systems (Simulation Modeling Practice and Theory Volume 38, November 2013, Pages 115–131).

4. OpenVPX Tutorial. http://www.vita.com/Tutorials

5. ANSI/VITA 48.2, VPX REDI: Mechanical Specifications for Microcomputers Using Conduction Cooling Applied to VPX.

6. ANSI/VITA 65-2010 (R2012), OpenVPX Architectural Framework for VPX.

7. For Ref. 2, uploaded file 2 of 2 -- HOST Standard Tier 2 6U v1.0 PAO SOR (2016). (Uploaded in SITIS on 4/22/16.)

KEYWORDS: Model; Optimization; Integration; Architecture; HOST; embedded system

TPOC-1: 301-342-9124

TPOC-2: 301-342-9113

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N162-085 TITLE: Analytical Tool for Design and Repair of Engine Hardware for Robust High Cycle Fatigue Performance

TECHNOLOGY AREA(S): Air Platform, Materials/Processes

ACQUISITION PROGRAM: JSF, Joint Strike Fighter

OBJECTIVE: Develop a robust analytical tool for the design and repair of high cycle fatigue (HCF)-resistant integrally bladed rotor (IBR)/blisk airfoils.

DESCRIPTION: Premature failure due to high cycle fatigue or in-service damage has plagued Naval Aviation throughout its history. This issue, for some aircraft propulsion systems, has resulted in a limited mission capability.

Good design, inspection, and maintenance practices have mitigated most safety-related risk from HCF, but maintenance costs and asset readiness are still a significant issue for aircraft engine operators. An analytical tool that can accurately portray the risk of current hardware and estimate the benefit of available surface treatments would allow the recent trend of reduced sustainment costs to continue.

Over the past decade, sustainment cost reductions have resulted from the application of compressive residual stress through surface treatments (e.g. shot peening, laser shock peening, low plasticity burnishing etc.) to compressor airfoils to improve HCF performance and tolerance to in-service damage. Generally, these "upgraded" airfoils were developed using simplified, deterministic analytical tools (or models), and components were qualified through extensive fatigue testing. Having a sophisticated analytical tool that is able to incorporate the residual stress fields of available surface treatments while incorporating probabilistic design for a more robust HCF design or for repair optimization is necessary to lower the sustainment costs and maximize the service life of IBRs/blisks.

Because probabilistic design systems are relatively new, their application to airfoils for increased HCF resistance is not accounted for. For example, much of the engineering and qualification of blade improvements, which relies on compressive residual stress imparted by surface treatments, has been deterministic (i.e. empirical, time and cost intensive). A more representative and efficient process for design of HCF resistant airfoils and airfoil repairs is needed, particularly given the cost savings that would result from extending the service life of IBRs/blisks. The design process for HCF-resistant airfoils and robust airfoil repairs should optimize deterministic surface treatment modeling while incorporating probabilistic design systems.

HCF resistance is more critical at this time because the HCF issue is more complex in the integrally bladed rotors (IBR)/blisk configuration found in propulsion systems as opposed to its bladed disk predecessor. The bladed disk configuration benefits from increased airfoil damping from the dovetail joint. However, the welded joint of an IBR/blisk configuration allows aeromechanical "cross-talk" between airfoils which may allow an airfoil that is not excited by its environment to become excited due to response of an adjacent airfoil. The welded joint of an IBR/blisk also nullifies the ability to remove blades following in-service damage which necessitates aggressive airfoil repairs to minimize scrapping of these costly, integral components.

HCF limits are reflected in engine design analysis using engineering models that are calibrated to coupon test data, and HCF performance is validated and certified through component and full-scale tests. Original engine manufacturer (OEM) design practices reflect variability in factors that drive HCF failures (like operational loads, usage cycles, and in-service damage) and in factors that provide HCF resistance (like strength, microstructure, and surface quality). The aforementioned sources of variability are robustly included in probabilistic design systems. As for airfoil repairs, or blends, they leave a given IBR/blisk in a unique condition relative to the design basis that does not benefit from the design practice of a pristine airfoil.

The envisioned analytical tool would be able to deterministically and accurately incorporate the residual stress profile (including the equilibrating tensile residual stress) as a function of depth in the airfoil post surface treatment while incorporating the probabilistic variability innate to airfoils (e.g. manufacturing, material, in-service damage, blend accuracy etc.) to produce a bounded distribution of benefits in the form of a failure rate. The failure rate enhancement due to a surface treatment should be apparent. The application of the analytical tool would be during the design process or as-needed in response to an in-service repair. At this time it is not necessary to model the surface treatment process but rather the residual stress output of any of these processes. Potentially there is opportunity to model the process for an all-inclusive analytical tool which would require an industrial partnership. The analytical tool should produce accuracies within 10% of the actual stress and maintain, or better, the mesh size of the parent finite element method (FEM) model. The analytical tool should leverage, where applicable, modern computer aided design and analysis software available in the market. Residual stress relaxation through loading or thermal effects shall also be considered.

A few applications that an analytical tool will facilitate:
- Component life assessment
- HCF design or surface treatment definition following a service-revealed HCF deficiency
- Airfoil serviceable limit expansion
- Airfoil repairable limit expansion

Collaboration with a major engine OEM is highly recommended, but not required.

PHASE I: Determine project feasibility and develop an analytical tool for the design of HCF resistant IBR/blisk airfoils. The analytical tool should be able deterministically model a depth-wise residual stress profile resulting from available surface treatments within the component's current FEM model. Demonstrate that the analytical tool can accurately portray the subsurface residual stress profile of a component with a surface treatment. The residual stress of that component should be confirmed with a conventional measurement technique (such as x-ray diffraction). Develop the probabilistic elements such as an understanding of geometric, material, processing, and airfoil damage variation, and a means to capture variation in an integrated design process. Demonstration that the probabilistic elements are understood should be provided but need not be integrated with the deterministic, analytical tool at this time.

PHASE II: Develop and validate an integrated deterministic/probabilistic analytical tool that can be adopted during the design process for HCF-resistant IBR/blisk airfoils and airfoil repairs. Demonstrate the architecture of the analytical tool and how it will be integrated into the design process of new or legacy IBR/blisk airfoils. Develop data and experience that show the degree to which the new design process would save sustainment costs. Demonstrate full deterministic/probabilistic analytical tool capabilities.

PHASE III DUAL USE APPLICATIONS: Finalize technology and assist the Navy in integrating the probabilistic design capability for HCF resistant IBR/blisk airfoils and airfoil repairs. Develop airfoil repair services, potentially in coordination with the OEM, that rely on the probabilistic design capability. Private Sector Commercial Potential: Emerging commercial aviation fleets have also committed to the use of integrally bladed disks in their compression systems. The analytical tool developed under this effort is directly applicable as an element of the design process of commercial turbine engines.

Residual stress is an industry-wide phenomenon that has attention in applications such as -- but certainly not limited to -- railways, bridges and gun barrels as well as processes such as welding, heat treatment and cold work.

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KEYWORDS: Model; Residual Stress; high cycle fatigue; probabilistic design; in-service damage; integrally bladed rotor

TPOC-1: 301-757-0486

TPOC-2: 301-757-3990

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N162-086 TITLE: Hardware Open Systems Technologies (HOST) Conformance Tool

TECHNOLOGY AREA(S): Air Platform, Electronics, Information Systems

ACQUISITION PROGRAM: Joint Strike Fighter F-35 Lightning II Program

OBJECTIVE: Develop an innovative conformance test tool which will support and add automation to the verification of hardware conformance to the HOST Standards for form factor and functionality that is implemented either in hardware or firmware (i.e. part of the software architecture).

DESCRIPTION: Hardware Open Systems Technologies (HOST) [1, 2] is an Open Systems Architecture (OSA) which defines virtual and physical interfaces to hardware such that interoperability and reuse of hardware components can be realized. The HOST standards leverage commercial technology combined with form factor such as the VITA Standards Organization's OpenVPX 6U standard [3, 4, 5]. In this example the OpenVPX standard allows flexibility such that vendor lock can still be accomplished. HOST constrains the use of the OpenVPX standard such that vendor lock is preventable. The intent of HOST is to establish performance and interface requirements that are open, enforceable, and testable. As diminishing supplies and obsolescence become more impactful, HOST will facilitate addressing obsolescence and diminishing supplies as well as capability growth from new and/or evolving requirements.

In order for HOST to enforce hardware interoperability, the interface requirements must be testable, both physically and logically. Currently there is no method other than a visual inspection, requirement by requirement, to assess conformance. For the purposes of this paper, visual means to read HOST requirements and search the hardware components supporting documentation to determine if the requirement is met. This process is both labor intensive and subject to errors, not to mention, not a true logical and physical interface verification. To make conformance testing more effective and less labor intensive, new methodologies to test hardware components must be developed to assess claims of component conformance and interoperability (both physically and logically).

Innovations, new methodologies and tools are required to facilitate testing so that conformance assessments can be accomplished in a cost effective manner which avoids barriers to entry for hardware suppliers. The objective of this topic is to obtain hardware/software solutions which will automate the verification testing of HOST hardware components. For the purposes of this topic, automated test refers to a combination of software and hardware which work to execute testing, report test findings and perform comparisons with the requirements in the standard as well as previous tests in a manner that minimizes human interaction [6, 7, 8]. The test tool should address form, function and electrical/mechanical interfacing of candidate HOST computer components as well as test for HOST-System Software functionality. The solution should be capable of testing OpenVPX 6U and 3U computer hardware to determine their adherence to the HOST requirements.

PHASE I: Determine project feasibility for the development of a HOST Conformance Tool. Based on industry VITA standards for OpenVPX and HOST Tier 1 and 2 standards, determine the areas of hardware conformance that are candidates for test automation. The HOST Tier 1 and Tier 2 requirements should be evaluated individually to determine on a per requirement basis which requirements can be automated for test. Determine an innovative approach to develop the tools to test the selected requirements and verify the feasibility / efficacy of the proposed approach. Document the findings and potential test tool architecture along with design decisions. Document the requirements where test cannot be automated and recommend other verification methods for each requirement.

PHASE II: Mature the test tool design and build prototype. Demonstrate a test tool capable of testing components. The form factor will be determined collaboratively with the government to determine if 6u or 3U or both are the targeted form factor.

PHASE III DUAL USE APPLICATIONS: The conformance tool should be matured and vetted such that it produces reliable results and can be relied on to output viable conformance test results. Coordination with PEO JSF to foster adoption and standardization of the HOST Conformance tool through development and test of the JSF mission computer obsolescence upgrade is required. Industry collaboration is highly recommended. Final result is a tool that can be utilized to test the HOST conformance of upgrades for the JSF mission computer that is accepted for use by the Navy and JSF platform integrators (industry). Private Sector Commercial Potential: This tool would be marketable to all HOST hardware developers and acquirers. It would likely also be valuable / applicable to those

applying the standards which make up the HOST Tier II standard (e.g. OpenVPX). The work performed under this SBIR could set a new paradigm for future testing of other commercial hardware (and potentially software / firmware) standards for conformance.

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1. Hardware Open Systems Technology – Tier 1 Version 1.0. (Uploaded in SITIS on 4/22/16.)

2. Hardware Open Systems Technology – Tier 2 Version 1.0. (Uploaded in SITIS on 4/22/16.)

3. OpenVPX Tutorial": http://www.vita.com/Tutorials

4. ANSI/VITA 48.2, VPX REDI: Mechanical Specifications for Microcomputers Using Conduction Cooling Applied to VPX.

5. ANSI/VITA 65-2010 (R2012), OpenVPX Architectural Framework for VPX.

6. FACE Conformance Verification Matrix. (Uploaded in SITIS on 4/22/16.)

7. FACE Conformance Policy. (Uploaded in SITIS on 4/22/16.).

8. FACE Conformance Test Suite. (Uploaded in SITIS on 4/22/16.).

9. For Ref. 2, uploaded file 2 of 2 -- HOST Standard Tier 2 6U v1.0 PAO SOR (2016). (Uploaded in SITIS on 4/22/16.)

KEYWORDS: Test; Open Architecture; HOST; Hardware; conformance; OpenVPX

TPOC-1: 301-342-9124

TPOC-2: 301-342-9113

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N162-087 TITLE: Onsite Structural Restoration Methods for Aircraft Components

TECHNOLOGY AREA(S): Electronics, Materials/Processes

ACQUISITION PROGRAM: PMA-276, H-1 USMC Light/Attack Helicopters

OBJECTIVE: Develop an innovative repair process that restores dimensional and structural capability of damaged Ti-6AI-4V aircraft components.

DESCRIPTION: There is an ongoing need for precise and effective methods for full dimensional and strength restoration of aircraft components to enhance the logistics and maintenance of Navy aircraft. There are many instances where Navy fleet aircraft components are damaged while in service before they reach their life limit. Causes of these damages are either maintenance induced, during component install/removal/handling/inspection, or service induced, due to foreign object debris (FOD). Typical damage includes nicks, dings, and dents. Current Navy aircraft components that are damaged in the fleet need to be sent back to a Navy depot for disposition and repair. Repairs generally include blending away the damages until the surface is smooth to reduce stress risers that may cause fatigue cracking. By blending, repaired components are left with a lower thickness in the repair location

which reduces the ability for future repair capability.

For all components, design tolerances exist. Damages that exceed those tolerances generally cause the component to be scrapped, costing the Navy hundreds of thousands of dollars each year. There are ongoing efforts to produce damage limits and tolerances (DL&T's) to increase the usability of aircraft components, but those too have limits which, when exceeded inevitably lead to scrapped components. The result is an increase in downtime for the fleet as the aircrafts age and as the number of spare parts goes down.

There has been considerable research leading to innovations in equipment and repair processes which can guide toward solutions of dimensional restoration on aircraft components. The Friction stir process [3] can be employed to refine the grain structure and remove porosity produced by other manufacturing processes, but it is yet to be proven as a viable deposition or repair option on its own. The cold spray process [1] has repeatability and uniformity of material deposition, while negating thermal residual stresses by being a solid state process. The main benefit of cold spray is the reduced thermal input, but porosity is common and its success is also limited with materials having poor malleability and high hardness. The metallic melt deposition process [2,4] is a highly versatile process that can produce fully dense structures from diverse materials. It is capable of producing uniform and repeatable deposition, while cooling rate control can lead to highly customizable and refined grain structures. Owing to the potential of metallic melt deposition to deposit free-form objects, it can be employed as a low volume quality production/repair process.

An innovative aircraft component damage restoration method is necessary to restore dimensional and structural capability and reduce the process time for the disposition and repair of Ti-6Al-4V aircraft components. The restoration method should result in a component with the same strength capability as an original non-damaged component. In addition, the resulting restoration method should be environmentally friendly, not require the use of hazardous materials, and should not generate or require the disposal of hazardous wastes, such as chromate containing primers and coatings.

PHASE I: Develop an innovative metallic melt deposition approach for the restoration of damaged Ti-6Al-4V aircraft components. Demonstrate feasibility of the developed approach by performing limited testing and characterization of the deposited material, substrate, and interface at a coupon level.

PHASE II: Fully develop the restoration process that can be applicable to an array of aircraft component geometries. Demonstrate the restoration technique on a demonstration article that is representative of basic geometries seen on aircraft components such as radii, edges, curvatures, etc. The demonstration article may be fabricated or purchased, damage induced, and then the repair process demonstrated. Fully characterize the resulting mechanical and microstructural properties achieved through the process through the use of coupon level testing.

PHASE III DUAL USE APPLICATIONS: Fully qualify the repair process and perform structural certification for the repair of specific military Ti-6Al-4V aircraft components. Transition the technology to military air platforms, as well as civilian cargo, passenger aircraft components, and other industrial applications. Private Sector Commercial Potential: The technology can be used for the restoration of aircraft components in both military and commercial sectors since Ti-6Al-4V components are widely used.

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KEYWORDS: Quality; Onsite Repair; Bonding; Process Robustness; Dimensional Restoration, Ti-6Al-4V Repair

TPOC-1: 301-757-9639

TPOC-2: 301-342-0297

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N162-088 TITLE: High Temperature, High Performance Wire Insulation

TECHNOLOGY AREA(S): Air Platform, Electronics, Materials/Processes

ACQUISITION PROGRAM: PMA-299, H-60 Helicopter Program

OBJECTIVE: Develop a high temperature, insulated wire construction for use in a flexible harness for engine applications, able to withstand the severe environment of an engine bay.

DESCRIPTION: Unique operating environments and conditions expose our systems and their components to extreme temperatures, moisture/humidity, altitude, fluids, vibration, and various other challenges. Unlike a majority of electrical/wiring applications that require harnesses and cables able to withstand temperatures up to 260C, a small number of Navy applications require flexible engine wiring harnesses to operate in continuous, high-temperature conditions exceeding 425C. While many options exist for high-performance wire insulations that can withstand up to 260C temperatures, currently no suitable insulations exist that can withstand continuous temperatures up to 425C while still maintaining the following Key Performance Parameters (KPPs) listed in order of importance.

• Temperature operating range of -55C to 425C
• Mandrel wrap bend test; insulation may not show evidence of visible cracks when wrapped around a six-inch mandrel, while under tension of two-pound weight after high-temperature endurance (MIL-DTL-25028J, para 4.6.4.a and para 4.6.5). Fluid immersion limited to sodium chloride-water solution, omit 4.6.4.b and c.
• Wet dielectric; meet minimum requirement of voltage and withstand insulation integrity test at 500 Volts RMS, 60 Hz after high-temperature endurance (MIL-DTL-25038J, para 4.6.4 and 4.6.6). Fluid immersion limited to sodium chloride-water solution for eight hours, omit 4.6.6.b and c.
• Insulation resistance; meet minimum requirement of 100 Megohms at 500V DC, per SAE AS4373 Method 504 after high-temperature endurance (MIL-DTL-25038J, para 4.6.6).
• Insulation outer diameter not to exceed MIL-DTL-25038/1 requirement of 0.125" ±25% (including conductor)
• Concentricity of wire insulation over the conductor, may be no less than 70% (MIL-DTL-25038J, para 3.4.2.2 and 4.6.2)
• 20-gauge conductor of K, of KP type (thermocouple ASTM E230), using 19 strand construction
• Needle abrasion of 1500 cycles at ambient temperature per SAE AS4373 Method 301 after high-temperature endurance at 425C (MIL-DTL-25038, para 4.6.4).

Several different insulations exist today that satisfy some of the KPPs listed above; however the requirement for this effort is focused on development of innovative materials and processes able to meet all KPPs listed above.

Wiring insulation will need to pass a 50-hour temperature endurance test (at two temperature extremes of -55C and

+425C), a 500-hour temperature endurance test (at two temperature extremes of -55C and +425C) and ultimately endure a 5000-hour temperature endurance test meeting all five of the KPPs outlined above and in accordance with the MIL-STDs listed in the References section of this topic.

PHASE I: Design, develop and demonstrate the feasibility of a new, innovative insulated wire construction which meets all the KPPs listed in the Description.

PHASE II: Further develop and produce a prototype wire insulation capable of meeting all the KPPs. Demonstrate the prototype by performing a 50-hour temperature endurance test (at two temperature extremes of -55C and +425C). Further modify and refine the insulated wire construction based on the results of the 50-hour test. Perform a 500-hour temperature endurance test (at two temperature extremes of -55C and +425C, with the goal of meeting all KPPs requirements outlined in the description.

PHASE III DUAL USE APPLICATIONS: Perform a full 5000-hour temperature endurance test meeting KPPs outlined in description. Additionally, all requirements in MIL-DTL-25038J (whichever is greater) must be met. Develop a commercialization plan to integrate the new insulation as necessary. Private Sector Commercial Potential: There is a current need for this type of insulation within the commercial engine application as well. This capability will allow for the use of high-temperature, flexible harnesses in current and future military and commercial engine applications.

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2. MIL-DTL-25038/1E, 01 December 2000. Wire, Electrical, High Temperature, Fire Resistant and Flight Critical, Normal Weight

3. SAE AS4373E, 03 February 2012. Test Methods for Insulated Electric Wire

KEYWORDS: Material; Insulation; Wiring; Electrical; Cable; Wire

TPOC-1: 301-342-2189

TPOC-2: 301-757-1101

TPOC-3: 301-757-0525

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N162-089 TITLE: Scalable Aircraft Hardware Open System Technologies (HOST) Prototype Development

TECHNOLOGY AREA(S): Air Platform, Electronics, Information Systems

ACQUISITION PROGRAM: Joint Strike Fighter F-35 Lightning II Program

OBJECTIVE: Develop, demonstrate and validate scalable hardware based on the design and interface requirements in the Tier 1 [1] and Tier 2 [2] Hardware Open System Technologies (HOST) standards capable of hosting traditionally developed software, as well as software designed/developed in accordance with more current openly available standards (e.g. Future Airborne Capability Environment (FACE) [3]).

DESCRIPTION: Today's military aviation airborne systems are typically developed for a unique set of requirements and managed by a single vendor utilizing proprietary interfaces. This stovepipe type of development process has served the military aviation community well in the past. However, it comes with some undesired side effects resulting from the fact that proprietary interfaces were used versus current state-of-of-the-art interfaces such as VITA standards for embedded hardware and the Ethernet standard for networking. Potential negative impacts of this closed interface approach include long lead times, cumbersome upgrade processes, and the lack of cross aircraft platform hardware/software compatibility which result in platform-unique designs. Ultimately, these proprietary interfaces force any change, even an obsolescence redesign to require a laborious effort (repeated for every change on every platform) to reanalyze these custom interfaces which only the system designer / integrator knows (and potentially slowly forgets the undocumented details over time) and verify that they are again implemented properly (potentially requiring reverse engineering). To counter this trend, the Hardware Open System Technologies (HOST) standard was developed. HOST is an open, high performance, cost effective, and truly sustainable embedded system architecture engineered with well-defined interfaces based on established industry standards (like VITA and Ethernet) at the component or HOST Module level, so that scalability and compatibility across the breadth of military platforms (e.g. aircraft, ground vehicles), systems (e.g. mission computers, displaces, radars, radios), and applications (e.g. mission, sensor, and image processing) can be achieved. This will also enable affordable integration of new technology based on the ease to integrate to a known interface (e.g. known / VITA backplane connections).

The HOST architecture provides the framework for developing embedded computing systems for U.S. military platforms. HOST compliant hardware, based on the referenced standards [1, 2, 3, 5, 6, 7], will change the paradigm of traditional hardware acquisition in much the same way that release of the IBM PC interface specifications in the 80's created the PC market and open architecture software standards have changed the portability of software (e.g. apps). HOST is anticipated to leverage capabilities of hardware only now being introduced to the embedded system market. It is also expected to create an infrastructure on which new software architectures (e.g. FACE) can be created. And when all of the benefits of FACE and HOST are eventually realized in conjunction with each other, embedded system application software will become portable and agnostic of the hardware on which it runs. For example, a processor upgrade funded by one activity (or a vendor interested in marketing upgraded performance in a backward compatible format) can be leveraged by any other activity within the Naval Aviation Enterprise (NAE) that is also based on the HOST Standard using the same Tier 3 specification.

The objective of and first priority (1) for this topic is to develop innovative prototype hardware (e.g. HOST module) capable of fulfilling the HOST interface requirements utilizing the smallest size (i.e. real estate on a VMEbus International Trade Association VITA 48.2 6U circuit card; e.g. <5% of the board real estate), lowest power (i.e. electrical power consumption, <1 watt / heat generation), smallest weight and satisfying the harsh military aerospace environmental requirements (e.g. 85 degree C maximum temperature). The prototype may either be in the 6U or 3U format (i.e. HOST Tier 2), which constrains the module in three dimensions (i.e. 233.35x100 mm 6U and 100x160 mm 3U with a =1 inch slot pitch for both). The second priority (2) for this topic is to provide the maximum flexibility in the means by which the HOST required interface is implemented. For example a design to include developing an innovative way to fulfill a particular Tier 2 requirement that allows the same hardware to fulfill two or more logical interface requirements over the same physical interface (e.g. switchable firmware setup interface protocol). The third priority (3) is to provide the most innovative capability to the proposed HOST module, again with the lowest space, weight and power (SWaP). Simple examples (in decreasing levels of complexity and likely innovation) include creation of a secure network server, a Single Board Computer (SBC), or VITA switch card. The fourth and final priority (4) is to fulfill HOST's overarching objective to show module level interoperability and interchangeability (i.e. the verification the interfaces are adequately defined and implemented by the HOST standard). Teaming across the embedded system market ecosystem to facilitate final transition is encouraged.

PHASE I: Design and determine the technical feasibility of building the most capable prototype hardware innovatively implementing the HOST standardized interfaces. Hardware having general purpose processing (e.g. SBC) should be capable of hosting traditionally developed software as well as software designed/developed in accordance with other open software standards (e.g. FACE). This phase should also include the software capability rehost analysis and design for any proposed general purpose applications (e.g. network server environment).

PHASE II: Develop and demonstrate prototype hardware and capability based on Phase I effort. Validate that the standardized interfaces defined by the HOST Standard (and any additionally proposed capability) have been implemented in the prototype by demonstrating the prototype in a multi HOST module environment. Include a demonstration of the interoperability of the prototype HOST modules on the NAVAIR development test asset which demonstrates interoperability and interchangeability between NAVAIR's reference system and the prototype developed under this SBIR. The NAVAIR test asset will conform to the HOST 6U OpenVPX Tier 2 standard including slot profile and Ethernet based manager/participant based protocol. The test asset and any necessary support will be made available as government furnished equipment (GFE) as agreed upon by NAVAIR POC and small business.

PHASE III DUAL USE APPLICATIONS: In coordination with a NAVAIR program office, identify a potential hardware system (e.g. secure network server, mission computer, display) for application of the demonstrated capability. Based on program office coordination, design and build hardware, and verify through system testing specific hardware capabilities above and beyond simple interfaces. Private Sector Commercial Potential: NAVAIR currently is developing the HOST standard as an open architecture initiative intended to become the standard upon which embedded systems are specified. The results of this SBIR have the potential to directly feed into future avionics systems being acquired by NAVAIR which will specify use of HOST. Both the Army and Air Force are also participating in HOST's development with the intent to also require HOST. The HOST standard is also starting to see increased interest from the private sector as the industry realizes the value of establishing an ecosystem of products and market niches for embedded system hardware similar to the current consumer electronics marketplace.

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4. NEXTGEN Avionics Roadmap, Version 2.0; www.dtic.mil/dtic/tr/fulltext/u2/a561244.pdf

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8. For Ref. 2, uploaded file 2 of 2 -- HOST Standard Tier 2 6U v1.0 PAO SOR (2016). (Uploaded in SITIS on 4/22/16.)

KEYWORDS: Interoperability; Avionics; Architecture; Mission Systems; FACE; HOST

TPOC-1: 301-342-9124

TPOC-2: 301-342-9113

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N162-090 TITLE: Adaptive Training System for Maintaining Attention during Unmanned Aerial Systems (UAS) Operations

TECHNOLOGY AREA(S): Air Platform, Human Systems

ACQUISITION PROGRAM: PMA-205, Naval Aviation Training Systems

OBJECTIVE: Develop an innovative and adaptive training system, techniques and computer-based simulation trainer, for Unmanned Aerial Systems (UAS) operators to maintain attentiveness during long shiftwork associated with extended UAS missions.

DESCRIPTION: With the expanding use of UAS comes the increasing need for UAS operators to maintain attention for long periods of time during the missions. Shifts of up to 12 hours in length are not uncommon. Shiftwork is associated with higher fatigue levels, degraded task performance and higher error rates [1]. While existing UAS simulations aim to train operators (i.e., Air Vehicle Operators, Sensor Operators) on job-related skills, there are no systems currently that focus on attention. Investigations of larger group 4 and 5 UAS mishaps have indicated that issues with channelized attention contributed to the mishap(s) [2]. Channelized attention occurs when all of an individual's cognitive resources are focused on one aspect of the environment, causing other equally important cues to be missed [2]. Intelligence, Surveillance, and Reconnaissance (ISR) type missions require sensor operators to track contacts of interest for extended periods in order to correctly identify and classify contacts of interest (COIs). Larger UAS are used for long surveillance type missions that require operator attention even if multiple crews are used. This research aims to develop tailored adaptive training techniques to minimize the issue of channelized attention. Training techniques capable of presenting long term mission requirements need to be developed, as no such technology currently exists.

Research on attentional training [3, 4] has indicated that it is possible to train attention and create effects that transfer to tasks after training. Further, a recent meta-analysis found that attentional training may be more effective if it is adaptive [4]. Adaptive training is broadly defined as any instruction that is tailored to an individual trainee's strengths and weaknesses so that the training experience varies from one individual to another based on either task performance, aptitudes, or test scores. Training can be adapted based on attributes measured prior to training, or during training based on task performance or scores. Many aspects of training can be adapted such as feedback, task difficulty, instruction, etc. The goal of adaptive training solutions is to provide the effectiveness of one-on-one tutoring through computer-based training that does not require an instructor in the loop [5].

Cost-effective, computer-based simulation training solutions that are able to adapt to the learning characteristics of different individuals [5], to the affordances inherent in UAS (i.e., operators are segregated from aircraft), and to the specific details involved with different missions are sought. This effort will develop adaptive training techniques and a computer-based simulation trainer that apply specifically to the UAS domain to aid and improve attention during long mission requirements. Pre-training and post-training evaluations should be performed to measure improvement in attention of UAS operators.

PHASE I: Design, develop and demonstrate a proof of concept for adaptive training techniques and a computer based simulation trainer to improve operator attentiveness during long shift work. System should accommodate different UAS missions, individual operator characteristics and learning styles. Develop protocol for approval of the use of human subjects in a training effectiveness evaluation.

PHASE II: Finalize the adaptive training proof of concept with the candidate UAS mission requirements within the computer-based simulation. Develop individual test subject baselines. Then, post-training, perform an effectiveness evaluation to demonstrate the improved attention of UAS operators.

PHASE III DUAL USE APPLICATIONS: Finalize all aspects of the training. Perform testing and prepare any and all necessary documentation, such as user's guides and instructor's manuals. Integrate the training solution into a full UAS training environment and to applicable UAS platforms. Develop commercialization plan to transition to industry/relevant users. Private Sector Commercial Potential: Advances in this technology are applicable to the gaming community, and digital tutoring technologies. Methods and technologies developed under this effort could be used by industries which use simulation in place of live training (e.g., commercial aviation, nuclear power generation, emergency management, law enforcement) to ensure that their training systems are warding off attention-related decrements in performance of tasks. Additionally, organizations specializing in training

effectiveness and workload assessment could employ the tools and techniques developed here to ensure consistent training outcomes and provide workload assessments for their clientele.

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KEYWORDS: UAS; Target Detection; Sustained attention; Adaptive training; Fatigue; Shift work

TPOC-1: 407-380-4331

TPOC-2: 407-380-4555

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N162-091 TITLE: Design Tool for Topological Optimization of Air-Platform Structural Components made by Additive Manufacturing

TECHNOLOGY AREA(S): Air Platform, Materials/Processes, Weapons

ACQUISITION PROGRAM: PMA-280 Tomahawk Weapons System; FNC: FY17 FNC titled: Quality Metal Additive Manufacturing

OBJECTIVE: Develop an integrated structural and material design tool that can exploit the benefits of Additive Manufacturing to produce novel designs for future weapon, target drone and unmanned air vehicle (UAV) structural components that cannot be fabricated by current methods.

DESCRIPTION: Increasingly complex aerospace components are limited by current manufacturing methods such as machining wrought forms, various forming, casting, and welding. Additive manufacturing (AM) can be used to fabricate complex components for use in naval aviation with the potential to enhance operational readiness, reduce total ownership cost, and enable parts-on-demand manufacturing. Future weapons, target drones and UAVs could benefit from the increased design freedom, supply chain efficiency, reduced material utilization and reduced energy consumption associated with AM technology. These factors are technology adoption “drivers” rated “high” for the aerospace industry [1]. Complex topologically optimized part designs (e.g., within today’s automotive industry) that

are a challenge to fabricate by current manufacturing methods can be made more easily with free form fabrication by AM equipment. Air-platform components such as fins, wings, and uniquely shaped ducts are examples of components that are ideally suited to AM.

A currently fielded missile wing, for example, consists of a ribbed-frame structure with skin bonded to its upper and lower surface. The frame is machined from a solid plate of aluminum alloy weighing more than ten times that of the 30-pound finished part. Through AM, material utilization can be reduced over 90 percent and the overall environmental impact and carbon footprint would be substantially decreased. The business case for using AM versus current manufacturing methods improves with decreasing size of production lots [2], which is typical of many contracts to procure weapons, target drones and unmanned air vehicles.

This topic will focus initially on wings and fins because the aerodynamically contoured shapes of these air-platform parts make them more challenging to fabricate using conventional methods. However, the ability to expand the tool's scope to include similar small parts such as stabilizers, rudders, flaps, ailerons, and winglets on UAVs should be considered as well. This topic is initially limited to use of AM processed aluminum or titanium alloys to develop an integrated structural and material design tool to support the manufacturing of these components more efficiently and with less cost. Significant work is ongoing [2] or being proposed in the areas of property definition, process qualification and certification for this process dependent manufacturing method, but defining AM properties for some process specific components remains a technical challenge. The proposed tool will be useful to designers during conceptual and preliminary design stages when component size, weight, performance and cost tradeoffs are being evaluated. To achieve this goal, an innovative methodology is needed to conduct part design and fabrication tradeoffs with an adequate degree of confidence using a total systems approach. An adequate level of confidence means that in a tradeoff between the AM-based design from this tool and an alternate conventional design, a similar level of confidence exists to enable a choice between the two options. Analytical "models" that characterize the AM material and process factors need to be developed and integrated with existing structural design tools (e.g. ANSYS [3]) used for topological optimization. The tool's ability to exploit the unique benefits of the AM trade space to produce lighter, stronger and less-expensive parts will enhance transition of this tool to the aerospace industry.

PHASE I: Develop and demonstrate the feasibility of a topological design tool for additively manufactured air-platform components such as wings and fins in order to reduce component size, weight, count and cost while meeting key performance criteria associated with the part design undertaken to include but not be limited to fatigue, aerodynamics, shock and vibration.

PHASE II: Develop and demonstrate the design tool into existing analysis and design tools. Demonstrate its utility by designing, fabricating and testing an air platform prototype component such as a wing or fin.

PHASE III DUAL USE APPLICATIONS: Perform final design modifications and final testing. Transition the integrated structural and material design tool for additively-manufactured air platform components to initial use supporting the conceptual and preliminary design activities during the development of a next generation air platform. Private Sector Commercial Potential: Additive manufacturing (AM) is utilized throughout commercial industry for prototype development and part production. This innovative analytical design tool would have applicability to the automotive, commercial aviation, and other industries seeking to increase design freedom and supply chain efficiency and reduce material utilization and energy consumption.

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KEYWORDS: Additive Manufacturing; Structure; Air Platform; Affordability; Complex Geometry; Design

TPOC-1: 760-939-5657

TPOC-2: 760-301-4145

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N162-092 TITLE: All Solid-State Batteries for Navy Applications

TECHNOLOGY AREA(S): Materials/Processes

ACQUISITION PROGRAM: 4.0T - CTO, Chief Technology Office

OBJECTIVE: Develop reliable all solid-state batteries (ASSB) with enhanced safety and performance by incorporating novel solid state electrolytes for naval aircraft applications.

DESCRIPTION: Naval aircraft currently use nickel-cadmium and lead-acid batteries to perform engine starts and provide emergency power. To improve energy and power density, the Navy is developing and transitioning lithium-ion (Li-Ion) chemistries for naval aircraft applications. For example, Joint Strike Fighter, F-35, currently uses a 28 Volt direct current (DC) and a 270 V DC lithium batteries on board. The demand is continuously increasing for high power, high energy, and long-lasting batteries without compromising on safety for naval aircraft applications. The potential gains of lithium-ion battery technologies are largely limited due to safety hazards associated with the organic liquid electrolytes, which are flammable, volatile, and corrosive.

Advances in overall Li-ion battery technology have resulted in significant improvements in battery electrode materials, liquid electrolytes, and, more specifically, solid electrolytes. Solid electrolytes present an opportunity to replace the liquid electrolytes. The solid-state electrolyte possesses desirable transport properties such as high conductivity, high diffusion coefficient, and high transference number, which have potential to eliminate fire hazards and can ensure the safe operation, protection, and longevity of the battery [1-2].

Recent discovery of a lithium super ionic conductor with 3-dimensional framework exhibiting high ionic conductivity (> 10-2 S cm-1 at room temperature) has revived interest in solid state ionic conductors and solid electrolytes [3]. The high ionic diffusion within the interstitial and vacancy sites of crystal lattices allowed the conduction network to achieve high conductivities for these solid electrolytes. The subsequent demonstration of using them as an electrolyte in an electrochemical cell demonstrated the possibility of an all solid-state battery.

New solid state electrolytes with high conductivity that are suitable for the current Li-ion battery chemistry architecture are needed. Innovative material design concepts to explore efficient solid ionic conductors should be considered. Solid electrolytes must exhibit thermal, chemical, and electrochemical stability. Material innovation coupled with novel fabrication techniques that would facilitate the realization of ASSB should also be demonstrated [4-7].

The ASSB system should demonstrate an energy density exceeding the 200 Wh/kg energy density threshold and 1500 W/kg power density threshold of current Li-ion batteries. The developed system must be compatible and functional with the existing aircraft operational, environmental, and electrical requirements. The requirements include, but are not limited to, an altitude of up to 65,000 feet, electromagnetic interference of up to 200 V/m, operation over a wide temperature range from – 40 degree centigrade to + 71 degree centigrade with exposure of up to + 85 degree centigrade [1], and withstand carrier based vibration and shock loads [6]. The ASSB system must meet additional requirements such as low self-discharge (< 5% per month), long calendar life (> 6 years service life) and good cycle life (> 6000 cycles at 100% depth of discharge cycles). ASSB system must have diagnostic and

prognostic capabilities to ensure safe operation and service life of the battery.

PHASE I: Develop innovative concepts to demonstrate the feasibility of an all solid-state battery at full cell level. Perform preliminary safety, electrical, and performance evaluations.

PHASE II: Develop a prototype ASSB system for demonstration, test and evaluation able to meet requirements as identified in the Description section. Demonstrate manufacturing feasibility. Evaluate cost estimates for manufacturing of batteries for meeting form, fit, function requirements.

PHASE III DUAL USE APPLICATIONS: Integrate ASSB system into Navy aircraft electrical power systems and demonstrate the functionality of the battery in a safe and effective manner in an operational environment. Obtain flight certification and transition the representative technology to appropriate Navy platforms and commercialize the technology. Private Sector Commercial Potential: Improvements made under this topic would be directly marketable to the commercial aviation, transportation and consumer electronics sectors.

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KEYWORDS: Safety; Battery; Electrodes; Liquid Electrolyte; Solid State Electrolyte; Solid State Battery

TPOC-1: 301-342-0365

TPOC-2: 812-854-4082

TPOC-3: 301-995-4559

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N162-093 TITLE: Airborne Multistatic Anti-Submarine Warfare Operator Target Detection and Discrimination System Workload Reduction

TECHNOLOGY AREA(S): Electronics, Sensors

ACQUISITION PROGRAM: PMA-264, Air Antisubmarine Warfare Systems

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 5.4.c.(8) of the solicitation. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop innovative solutions to enable an operator to efficiently detect and discriminate a target(s) in an airborne multistatic Anti-Submarine Warfare (ASW) mission.

DESCRIPTION: Multistatic sonobuoy fields [1] for air ASW search mission are becoming more complex. The ability to utilize more sources, more receivers, and the resulting higher transmission rates provide an influx of information. As a result, the detection capabilities and data rate for contact reports (automatic detections produced by the received signal processing) is increasing dramatically. It is no longer practical for a sonar operator to be able to sift through detections one-by-one to find the target.

Techniques and tools which consolidate information from the contact reports and provide the operator with the capability to rapidly find and focus on target detections are sought. Typical active contact reports provide time difference of arrival (TDOA), bearing, signal-to-noise ratio (SNR), and, Doppler [2, 3], depending on the waveform type. Geographical locations based on these measurements and the positions of the sonobuoys are also typically displayed to the operator, along with a target probability surface [4] based on Bayesian inference from the observations. Innovations in graphical display of data that ease the operator's workload, ranking of contacts to bring target detections to the forefront, and automatic suppression of clutter are potential topics of interest.

Focus Areas / Elements of Consideration:

- Information Superiority; the ability to gather, process, integrate, disseminate, and display information together with a corresponding increase in the ability to use that information.
  - o Data Fusion; combining track information from a variety of sources into a single best picture of the tactical operational area.
- Situational Awareness / Assessment; continually monitoring the dynamic picture for impacts to the plan (recognizing potential limitations in the mission plan).
- Mission Planning; recommending updates / changes to the operational plan to ensure the highest probability of detection is possible.
- Execution Aides, assisting the crew in executing the operational plan / mission.
  - o Automation, how the information is provided within the elements of the decision-making. The Tactical Decision Aides (TDA) should be prosthesis, adding additional capabilities to the operators, or simply as a tool available to the operators. The TDA shall assist, or replace, the operator when the situation causes an excessive workload that cannot be managed by the human capabilities. These approaches are not mutually exclusive, but complementary, depending on situation context, the specific nature of the TDA element and the operator's role.

Targeted innovate solutions include:

- TDA:
  - o Algorithms.
  - o Software.
  - o Graphical tools.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by DoD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Security Service (DSS). The selected contractor and/or subcontractor must be able to acquire and maintain a secret

level facility and Personnel Security Clearances, in order to perform on advanced phases of this project as set forth by DSS and NAVAIR in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advanced phases of this contract.

PHASE I: Research and investigate the suitability and feasibility of proposed technique(s) to significantly improve an operator's ability to determine target detection(s) using simulated data at representative rates. Develop and demonstrate a conceptual model or process for an Airborne Multistatic Anti-Submarine Warfare Operator Target Detection and Discrimination System which meet the requirements stated in the Description section.

PHASE II: Design and develop an engineering level (beta) TDA and prove, by technical demonstration, the proposed technique(s) by processing existing real world data collection sets and measure the resulting improvement in operator performance in accordance with the parameters in the description.

PHASE III DUAL USE APPLICATIONS: Develop a production level TDA. Based on the Phase I and II efforts, develop a timeline / plan / process for implementation of the TDA and assist in transitioning the product to the commercial sector and Air ASW community through the Advanced Product Build (APB) process. Private Sector Commercial Potential: The ability to find targets in high duty cycle pulsed active sonar systems with multiple active sources is of interest to the U.S. Navy surface ship community to protect carrier strike groups. It has potential commercial application to harbor protection, security of shipping lanes, and marine mammal detection.

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KEYWORDS: Workload Reduction; Multistatic; clutter reduction; sonar automation; Bayesian inference; ranking

TPOC-1: 301-757-5733

TPOC-2: 301-342-8234

TPOC-3: 301-757-3694

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N162-094 TITLE: Sensory System to Transition Pilots From Aided to Unaided Vision During Flight to Mitigate Spatial Discordance

TECHNOLOGY AREA(S): Air Platform, Human Systems

ACQUISITION PROGRAM: JSF, Joint Strike Fighter

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 5.4.c.(8) of the solicitation. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a system to seamlessly transition pilots from aided to unaided vision while performing night operations.

DESCRIPTION: When pilots transition from aided to unaided vision during flight, the number of visual cues that can be used as reference for aircraft attitude is greatly reduced. If this occurs during night operations with very low ambient light, spatial discordance can occur. Rapid transition from aided to unaided vision reduces the number of peripheral visual cues from many to few, which can lead to spatial disorientation and unsafe flight. Dark adaptation, or the ability to perceive low-level light, can take as long as half an hour [1, 2] to achieve. Other cues that indicate the attitude of the aircraft must be made present to mitigate the effects of night-vision aides on the visual system, where a light-adapted eye must quickly transition to extremely dark conditions.

A lack of sufficient peripheral visual orientation cues may lead to a number of spatial discordance issues (e.g., black-hole effect) [4]. Peripheral visual cues are reduced during a dark night or white-out (atmospheric or blowing snow) conditions. In either case, it is the lack of peripheral visual cues that lead to disorientation. Another situation in which pilots require peripheral visual cues is when approaching and closing in on another aircraft (e.g., in-flight refueling). Pilots use peripheral cues to estimate their relative position to the Earth and the aircraft to which they are approaching [4]. Without this peripheral information, as it occurs in extremely dark conditions, closing in on another aircraft becomes significantly more challenging and potentially dangerous. Currently, pilots rely on the plane's attitude indicator, a visual representation of the plane's position relative to the horizon, when experiencing spatial discordance. This visual cue provides information to the foveal visual field and does not take advantage of the benefits of cuing peripheral sensory receptors. Although this information is quite salient in the foveal visual field, pilots report dismissing this information since the vestibular cues they experience provide more compelling evidence of their (incorrect) spatial orientation.

As previously mentioned, peripheral visual cues are a major contributor to maintaining straight and level flight and avoiding spatial discordance. More recent research, however, has demonstrated that spatial information can be improved with multimodal (i.e., vision, hearing, tactile) stimulus presentation [1,3]. With the appropriate combination of more than one stimulus modality, humans can orient themselves more quickly and accurately than with the activation of one sensory modality alone [1,3]. Rupert (2000) demonstrated that vibrotactile arrays can provide enough situational awareness for helicopter pilots to navigate some maneuvers while blindfolded [5].

Technology with the ability to provide a pilot transitioning from aided to unaided flight, additional stimuli to maintain straight, level, and safe flight is needed. This technology can use any stimulus modality or use a multimodal approach. It should be able to be activated at the pilot's discretion and suitable for different platforms that have different requirements and constraints. At a minimum, however, this technology should be applicable to Navy 5th generation fighter aircraft. Since the only 5th generation fighter in the current inventory is the F-35 Lightning II, this technology should be compatible with the current cockpit design and successfully integrate with the baseline pilot-vehicle interface (PVI).

No additional weight should be added to the helmet; some possible solutions may involve adding devices to the helmet, which is not permitted. If power is required, it must be limited to the accessory power generated by the aircraft. If possible, the technology should extend to previous generation fighters and other aircraft (e.g., helicopters) – relevant aircraft cockpit specifics will be provided, as needed, during the development of this technology. Although the vibrotactile approach demonstrates some promising research avenues, Fourier transform analyses suggest wide encompassing of resonant frequencies within the cockpit that can prove problematic for the

frequency at which vibrotactile arrays provide situational awareness. If a vibrotactile solution is proposed, it is necessary to convey the (1) distinctiveness of the approach; (2) the durability of the system (e.g., sturdiness after cleaning, lifetime strength); and (3) mitigation of resonant frequency issues in the cockpit.

Collaboration with original equipment manufacturers, (OEMs) in all phases is highly encouraged to assist in defining aircraft integration, commercialization requirements, and providing test platforms.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by DoD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Security Service (DSS). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances, in order to perform on advanced phases of this project as set forth by DSS and NAVAIR in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advanced phases of this contract.

PHASE I: Develop and prove feasibility of an approach that demonstrates the ability for a pilot to orient themselves more quickly and accurately than current technology allows. Provide documentation that demonstrates the suitability of the design into representative platforms and mission environments; platform and mission environment data to be provided by the government upon award. A proof of concept demo should be performed along with a Technology Readiness Level (TRL)/Manufacturing Readiness Level (MRL) assessment.

PHASE II: Develop the system into a prototype, perform further testing in a relevant environment, and demonstrate performance in a simulated or actual flight environment. Tests during this phase should demonstrate the superiority of the new system compared to the standard avionics used during spatial discordance. Feasibility of aircraft/fighter integration should also be demonstrated. TRL/MRL assessment should be updated.

PHASE III DUAL USE APPLICATIONS: Perform final testing to the system in an actual flight environment to prepare for integration into both naval and commercial platforms. Aid the Navy in transition and integration of the system into the Fleet and all appropriate testing-and-evaluation programs. Private Sector Commercial Potential: This system would be useful in the private sector civilian aviation as spatial discordance has been found to be a large contributor to civilian mishaps as well.

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KEYWORDS: Spatial orientation; spatial discordance; peripheral cues; vision; multisensory; sensory system

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Questions may also be submitted through DoD SBIR/STTR SITIS website.

N162-095 TITLE: Novel Multi-Axial Fatigue Analysis Tool for Dynamic Components using Frequency Domain Method

TECHNOLOGY AREA(S): Air Platform, Space Platforms

ACQUISITION PROGRAM: PMA-276, H-1 USMC Light/Attack Helicopters

OBJECTIVE: Develop a novel repair assessment and remaining useful life analysis tool for rotorcraft dynamic components using a frequency domain fatigue analysis method which takes into account the effects of multi-axial, local plasticity, and damage state of the component.

DESCRIPTION: During service operations, aircraft structures sustain damage. That damage is routinely discovered via inspection and subsequently repaired. This damage is often caused by fatigue, corrosion, accidents, and mishaps. Repairs are performed to restore the integrity of the part to the original part strength and durability. However, some repair operations involve improper blending/grind-outs, or over-stiffening that may move the fatigue critical locations to another point in the structure causing cracks to start in new locations. There is currently no standard repair procedure that applies to all cases. The problem of improper repair is even more acute on rotorcraft dynamic components because of their constant exposure to damaging environments and increased frequency of incidents.

Analysis of each repair for strength, durability, and damage tolerance is an involved process as it requires evaluation of static and fatigue margins and impact on adjacent structures. In some cases, there are load redistributions because of local changes to stiffness and geometry that need to be analyzed by finite-element (FE) analysis. The complexity of repair assessment further increases if the structure or component is subjected to multi-axial loadings.

Fatigue evaluation in spectral methods is typically simplified by substituting spatial tri-axial stress state to the equivalent uniaxial one with suitable failure criteria. Appropriate probabilistic characteristics are then applied for calculations of fatigue life under the uniaxial random loading. Components under random multi-axial loading need multi-axial fatigue analysis at numerous critical points which requires significantly higher computational effort. In addition, the local plasticity affects at stress concentrators needs to be incorporated in the solution. An alternative novel formulation of multi-axial fatigue analysis under random loading is needed.

Assessment of repair work done in service on dynamic components requires a quick and reliable fatigue damage evaluation method which takes into account the effects of static and dynamic response of the component for a given loading exposure and application of the right fatigue methods to investigate the impact on fatigue life. The recent advances in structural analysis methods and fatigue damage evaluation using frequency domain methods offer the potential to quickly evaluate and assess the repair work of components subjected to complicated service loads.[3, 4]

Develop an analytical tool to assess repair and evaluate remaining useful life of dynamic components in service. The tool must consider local repair geometry, load redistributions, and static and dynamic response to quickly assess strength, durability and damage. The tool must also be general enough to address simple to complex repair geometries and loading situations. This analysis tool should address both static and dynamic analysis needs, damage evolution within the component, and different responses to dynamic excitation due to the presence of damage. In addition, the tool should be able to efficiently calculate accumulated damage starting from input service histories and include quasi-static and dynamic events in complex loading sequences and superposition effects.

Though not required, coordination with original equipment manufacturers (OEM) is recommended throughout the

effort.

PHASE I: Develop an innovative, analytical tool using frequency domain methods to assess strength and durability of repaired dynamic components subjected to quasi-static and dynamic excitations. Demonstrate proof of concept and efficiency of solution.

PHASE II: Further mature the approach developed under Phase I to include the effects from a variable multi-axial stress state, local plasticity, and the resulting changes in component dynamic and static response to accumulated damage. Demonstrate the accuracy of the numerical solutions for repair assessment using experimental data of varying degrees of complexity and type of loading. Integrate the methodology within a user interface environment to enable the analysis of components starting from its geometry, applied loads, and boundary conditions.

PHASE III DUAL USE APPLICATIONS: Commercialize and transition the developed repair assessment and remaining life prediction tool as an analysis package. A detailed verification and validation effort will be performed along with a demonstration of application capability in a production-type and widely used tool. To further the technology transition, the developed repair could be installed and flight tested on a fleet representative airframe in with cooperation with the interested PMA(s) and OEM. Private Sector Commercial Potential: Methods and techniques developed can be included in a commercial software package for broad use in a wide variety of industrial applications in order to estimate the life of safety critical structures and components.

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KEYWORDS: Durability; Multi-Axial Fatigue; Remaining Useful Life; Frequency Domain Fatigue Analysis Method; Multi-Axial Loads; Repair Assessment

TPOC-1: 301-342-0297

TPOC-2: 301-342-9359

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N162-096 TITLE: Pocket-sized Surface Flotation Device for Cold-Water Aviation Survival

TECHNOLOGY AREA(S): Air Platform, Human Systems

ACQUISITION PROGRAM: PMA-261, H-53 Heavy Lift Helicopters

OBJECTIVE: Develop a surface flotation device for an aviation mishap survivor that is pocket-sized, has a method for easy entry, and provides protection from exposure to cold water.

DESCRIPTION: Flying over cold water is a hazard increasingly faced by all military aviators. The possibility of having to ditch the aircraft is one of the most dangerous exigencies, as death can occur quickly from immersion hypothermia when the aviator is not properly protected. Survival in cold water is dependent upon three things; not drowning, staying alive until rescued, and being found. The best chance an aviator has to survive ditching is offered by surface flotation devices. A combination of the life preserver, a dry suit, and a life raft are currently available to aviators. All three components are minimum-required survival equipment for all services, but the life raft is the most versatile and functional component of the cold water survival triad.

Current life rafts are typically aircraft-specialized and logistically hard to manage. Rafts are developed for the limited storage space constraints onboard the aircraft. With different raft types, come different sizes of carbon dioxide bottles; different manifolds with different inspection cycles and procedures; and different spares, repair parts, and consumables. This fracturing of demand across a myriad of rafts and spares often results in persistent supply deficits. Current life rafts are typically sized to hold multiple crewmembers, are heavy and bulky, and are built to withstand improvised stowage, crash damage, and long sea exposures. Depending upon the number of aircrew the raft is designed to hold, it can weigh more than 100 pounds, and the packed dimensions can be as large as 1x2x3 feet. Single man life rafts are also currently too bulky to mount on the person. Logistically, the opportunity cost of carrying rafts equals the commensurate amount of fuel, ammunition, or other cargo that must be left behind in order to make room for the raft. Existing life rafts are difficult to deploy and very hard to board. Swimming through an escape hatch with only a survival vest and life preserver, or wrestling a multi-person raft out of the aircraft, often through only the main door, can be crowded in an emergency situation. Despite the addition of boarding aids, getting into the raft remains one of the most difficult in-water survival tasks. Currently, rafts are designed to keep water out, and therefore must have high sidewalls. High sidewalls on a raft are a problem because once the aviator is in the water with an inflated life preserver, the life preserver lobes act like boat fenders, inhibiting the ability of the aviator to board the life raft. Deflating the life preserver lobes is often necessary to allow boarding, a counterproductive burden and threat to the survivor.

Current one-man life rafts weigh between 4.2 and 5.25 pounds and are not worn on the person due to the bulk not fitting onto the survival vests along with the other required survival gear. Lighter, less bulky and more durable surface flotation devices to supplement the flotation provided by the life preserver are a chronic and documented need. The aviation life raft and life preserver have not changed significantly in more than fifty years. In routine use, inadvertent or failed inflation has been reported, and in cold temperatures, carbon dioxide cannot expand rapidly, creating slow or partially filled conditions that jeopardize boarding, stability, and buoyancy.

Develop a surface flotation device that can be worn or carried on the aircrew without interfering with flight duties and integration with aircraft and survival equipment, be pocket-sized, easy to board and more usable than existing devices. Aircrew will continue to wear their life preservers and will carry this device as an additional means of anti-exposure protection. In addition to the anti-exposure suit worn in conditions where the sum of the air temperature and water temperature are less than 130 degrees Fahrenheit (F), the device should provide additional protection from exposure to cold water. Innovative approaches involving the leveraging of the recreational raft market, use of novel raft construction, and micro-inflator technologies are sought.

The device should:
• be able to fully lift the wearer from the water while providing a 1 inch air gap between the user and the water;
• not impede with survivor egress from the underwater aircraft (i.e., inherent system size to be no greater than 1x3x4 inches);
• achieve deployed form in less than 60 seconds (ideally, 15 seconds);
• have a maximum weight of 5 pounds;
• maintain intact flotation in rough seas for 72 hours;
• be one-size-fits-most (small female to large male) device;
• enable survivor-capable repair, while in water, that is capable of lasting for 72 hours;

• withstand an 11-hour flying time in routine ambient conditions (0 degrees F to 120 degrees F);
• provide resistance to environmental contaminants (e.g., sand, petroleum, oil, lubricants, solar radiation);
• survive prolonged exposures to temperature extremes of negative 20 degrees F to positive 140 degrees F;
• be mold and mildew resistant;
• be flame resistant;
• be salt fog resistant;
• ensure compatibility with current military gear and equipment required to be worn with military dry suits (such as armor, masks, gloves, helmets, and boots);
• be nontoxic to the skin;
• and have a low propensity to sudden static discharge or exposed surfaces.

PHASE I: Design and determine the feasibility of a concept pocket-sized surface flotation device that provides protection from cold water exposure and meets the requirements provided in the Description above. Demonstrate feasibility through analysis and limited laboratory demonstrations. Provide cost and reliability estimates.

PHASE II: Develop, demonstrate, and validate a prototype pocket surface flotation device based on the design concept created in Phase I. Demonstration of device operation and capabilities, except for raft boarding can be conducted in a laboratory environment. Demonstration of raft boarding must be conducted in a facility that trains personnel for underwater egress and survival, using certified safety swimmers. When a prototype has been delivered, a demonstration will be performed by the Government using Navy divers representing the 95th percentile male human subject in controlled immersions, in compliance with the requirements provided in Phase I. Provide draft engineering drawings and benefit and cost/life-cycle cost analyses.

PHASE III DUAL USE APPLICATIONS: Perform any final design updates based upon the prototype testing in Phase II. Develop mass production capability of the pocket surface flotation device and commercialization for the private sector. Provide updated engineering drawings, detail specifications, and benefit and cost/life-cycle cost analyses. Private Sector Commercial Potential: The transfer and modification of commercial technology is common for efforts like this. Novel alternative flotation devices can benefit other military, industrial, and recreational aviation operators and passengers, as well as industrial, merchant, and recreational marine operators and their crews or passengers. This flotation device also could possibly be adapted for cargo transport protection and/or salvage.

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KEYWORDS: Survival; Life Raft; Surface Flotation/Floatation; Immersion Hypothermia; Buoyancy; anti-exposure

TPOC-1: 610-746-3599

TPOC-2: 301-342-8403

TPOC-3: 901-937-1732

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N162-097 TITLE: Non-Contact Torque Sensor for Unmodified Composite Shafts and Non-Ferrous Metal Shafts

TECHNOLOGY AREA(S): Air Platform, Sensors

ACQUISITION PROGRAM: PMA-265, F/A-19 Hornet/Super Hornet

OBJECTIVE: Develop a non-contact torque sensing capability for pre-existing, flight-qualified, rotating drive shafts made from carbon fiber reinforced composites, titanium alloys, and aluminum alloys.

DESCRIPTION: A torque sensing solution for both nonferrous metals and carbon-fiber reinforced composite shafts that does not install onto, or modify the drive shaft is needed. The Navy currently does not have the ability to measure and monitor torque of these shaft types. It is necessary that the solution not contact the shafts so that dynamic balance of the shaft under measurement would not be affected; the shaft deflections common during operation would be less likely to damage the shaft or the instrumentation; and no changes would be required in the approved production design and quality build control of the drive shafts. Since no modifications would be done directly to the drive shafts, no expensive, time-intensive requalification of the drive shafts would be required.

The goal is to deliver a non-invasive torque sensing capability that has the least possible impact on existing and next generation US Navy aircraft designs, while also enabling practical upgrades to existing platforms to meet expanding mission requirements. The sensor should measure torque up to a minimum of 2kHz with recorded data rates exceeding a minimum of 5kHz. The sensing solution should provide sufficient dedicated data storage for a single extended operation, as well as mechanisms to retrieve and access the data. The torque measurement system should accommodate a shaft that is no more than 10 inches long and between 2 and 5 inches in diameter, operating at a nominal speed of 18,000 RPM with torque values of +/-5000 in-lb. The torque measurement accuracy error must be no more than 2% of full scale value. The system should maintain this accuracy over varying operating temperatures, -25 degrees C to 80 degrees C; utilizing temperature compensation as required. The system must operate within this accuracy for pressure altitudes from sea level to 40,000 feet.

The solution must provide data rates above 5 kHz and enable diagnostics as well as life management based on the solution's torque measurements. The sensor solution must not modify the shaft in any way. All components of the sensor solution must be stationary. The sensor solution must have a large enough gap between the sensor and the rotating shaft to prevent any contact with the shaft during the severe flight maneuvers that generate large shaft deflections. The sensor solution should be practical for use in a U.S. Navy aircraft experiencing day/night operations, shipboard electromagnetic interference, and corrosion-dominant sea-based operational environments [3, 4]. If the sensor can measure the shaft speed, deflections, and bending stresses, this should be noted in the proposal.

Working with original equipment manufacturers (OEM) is highly recommended but is not required.

PHASE I: Design, develop and demonstrate feasibility of a non-contact torque sensor concept that meets the parameters outlined in the Description.

PHASE II: Based upon the design from Phase I, develop and demonstrate a prototype non-contact torque sensor in a laboratory setting. A laboratory bench top capability demonstration should clearly establish the feasibility of the method on both a non-ferrous metal shaft and a composite shaft in a realistic operating environment. This demonstration must include a non-ferrous spinning shaft with variable applied torque and non-contact torque monitoring. Data collected from this test should be compared to calibrated strain-gauge measurements, in-line torque sensors or a suitably accurate dynamometer, and taken during the same tests to meet above mentioned accuracy requirements. This full-scale demonstration should use shaft materials that are both typical of current nonferrous metal shafts and of next generation composite shafts.

PHASE III DUAL USE APPLICATIONS: Installation of a ruggedized and calibrated prototype torque sensor and any associated devices on in-service Navy aircraft and initial flight testing should be accomplished in coordination with an aircraft OEM. Flight testing should include day/night operations and should exercise the authorized aircraft

flight envelope to account for expected airframe and driveshaft distortions. If any expected temperature limitations exist with the torque sensor system, these limitations should be tested during flight test to the extent feasible in prevailing ambient temperatures. Data should be reviewed and compared to any existing data for verification of performance. A cost analysis for future production incorporation or retrofitting within current propulsion systems and commercial applications should be conducted to demonstrate benefits. Private Sector Commercial Potential: Commercial rotorcraft would benefit from a reliable non-contact torque measurement solution. There are also numerous applications where non-contact torque measurement would be beneficial, to include industrial, agricultural and automotive industries.

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3. MIL-STD-810G – Department of Defense Test Method Standard: Environmental Engineering Considerations Laboratory Tests (31 Oct 2008). Retrieved from http://everyspec.com/MIL-STD/MIL-STD-0800-0899/MIL-STD-810G_12306/

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KEYWORDS: Composite; condition-based maintenance; non-contact; non-ferrous; torque; drive shaft

TPOC-1: 301-757-2504

TPOC-2: 301-995-2946

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N162-098 TITLE: Aircraft Deck Motion Compensation Design

TECHNOLOGY AREA(S): Air Platform

ACQUISITION PROGRAM: PMA-268, Navy Unmanned Combat Air System Demonstration

OBJECTIVE: Develop deck motion compensation algorithm and control law design methodology and guidance via airborne and/or shipboard sensors (e.g. GPS and rate/acceleration gyros) to improve aircraft boarding rate capabilities in high ship motion conditions.

DESCRIPTION: The Navy continues to invest in the development of shipboard automated landing systems and Unmanned Air System (UAS) capabilities. One important area of investment is improved boarding rates in high sea state conditions with large ship motions. Due to legacy systems' computational and hardware restrictions, current systems only account for the basic movement of the touchdown point with altitude rate and bank angle commands. The systems become unreliable and unusable as the sea state increases which then greatly increases pilot workload and decreases recovery rate. Autonomous and highly augmented aircraft can integrate more sensor information and increase boarding rates using advanced data fusion and control algorithmic techniques. The Navy's Unmanned Combat Air System demonstration (UCAS-D) program successfully completed several carrier demonstration events

using a more advanced deck motion compensation (DMC) scheme, but only in benign sea states.

Control law methods for ship motion and aircraft data fusion and flight control are needed to enable Naval Aviation operations at the worst sea state conditions. These types of algorithms exist and have been used in the past in limited scenarios (i.e. X-47B) and disparate scenarios (e.g. relative position flight control of UAS in swarms). Unfortunately, the implementations have relied on extensive analysis techniques (e.g. Monte Carlo variations of environmental conditions and sub-system capabilities) to test the robustness and precision of the control systems, or were flight tested without airworthiness certifications. Early design and performance guidance (including sensitivities to sensor accuracy, precision, data rate, latency, and reliability), for deck motion measurements, prediction methods, sensor noise and errors, and DMC control algorithms need to be created to support future aircraft development and improvements.

A design guidance and conceptual analysis toolset is needed for existing simulation environments to demonstrate the six-degree-of-freedom (6DOF) simulation response of an aircraft during a shipboard recovery. The environments need to be able to incorporate variations in ship deck (landing/recovery location) motion, environmental disturbances (e.g. turbulence, ship airwake, etc.), and sensor errors/noise to assess the feasibility of the developed design guidance using DMC algorithms and control law design methodology and analysis tools.

PHASE I: Develop preliminary detailed aircraft design guidance for DMC control schemes addressing deck motion measurements, prediction methods, sensor noise and errors, data fusion, aircraft performance, and flight characteristics and control. Develop a conceptual analysis toolset for ship-based recovery and show feasibility of the design guidance with a prototype DMC control method and publically available shipboard environment inputs. The preliminary design guidance and conceptual analysis toolset will be evaluated against algorithm coverage scope, system level accuracy (e.g. approach flight path maintenance and touchdown point location), robustness to control law methods and variations in input data, and incorporation of sea-based aviation environmental considerations.

PHASE II: Mature the DMC design guidance and analysis toolset using multiple prototype DMC schemes, including data source fusion and control algorithms. Perform sensitivity analyses on the DMC schemes to determine what information, and the associated sensor accuracy, precision, data rate, latency, and reliability, needs to be fed back to the system. Identify the data and information types that are required for successful DMC schemes, those that provide improvements to boarding rate and reliability, and the ones that do not impact a DMC scheme performance. Identify flight control law techniques (e.g. vehicle control of flight path, attitudes, rates, accelerations, etc.) and develop associated design and performance guidance for DMC concepts. Show feasibility of the design guidance by evaluating how aircraft performance capabilities and flight limitations affect the DMC schemes performance and reliability. Document the design guidance with technical rationale including the results of the sensitivity studies and the impact of the individual criteria on the overall system's recovery capabilities.

PHASE III DUAL USE APPLICATIONS: Finalize and transition the DMC design guidance and analysis toolset by validating them with additional aircraft and simulation sources, as required. Integrate the results into future Navy programs, such as UCLASS, Fire Scout, RQ-21A, F-18, and Joint Strike Fighter, to enable the development of advanced shipboard landing control laws with DMC. Private Sector Commercial Potential: The deck motion compensation concept design guidance and toolset developed under this SBIR are relevant in applications beyond Navy shipboard approach and landing. The underlying technologies can be used with commercial off the shelf UAS platforms that operate on personal, research, or corporate ships to provide improved recovery performance and operational usefulness. Other applications include other two-body relative navigation like formation flight, swarm operations, and vehicle tracking.

REFERENCES:
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KEYWORDS: Airworthiness; Unmanned Air Vehicle; Shipboard Landing; Ship Motion; Control Law Design; Sea-Based Aviation

TPOC-1: 301-995-2038

TPOC-2: 301-342-5840

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N162-099 TITLE: Multistatic Transmission Loss (TL) Estimation

TECHNOLOGY AREA(S): Electronics, Sensors

ACQUISITION PROGRAM: PMA-264 Anti-Submarine Warfare Systems

OBJECTIVE: Develop a robust Transmission Loss (TL) estimation capability for multistatic Anti-Submarine Warfare (ASW) sonars that can be used to reduce the operator workload by eliminating clutter.

DESCRIPTION: New functionalities in ASW for active multistatics, such as operating multiple sources simultaneously, and the resulting higher transmission rates provide enhanced detection capabilities. However, there is an increase in false detections, leading to an increased operator workload. One approach to reducing operator workload is to use TL estimation to help discriminate clutter from possible target echoes.

The challenge exists in that TLs can vary significantly depending on the environmental state, bathymetry of the ocean at the time, and location of a given sonar transmission(s). Therefore, it is not possible to empirically measure either the TLs themselves or even to fully measure the environmental state of an operational area prior to an ASW mission. In order to achieve an implementable solution that operates robustly in a wide range of locations and environmental conditions, it is necessary to develop statistical models that adequately estimate the TLs for a given location, sensor geometry, and set of environmental conditions.

Emphasis should be placed on the development of algorithms and software that utilize historical data with in-situ measured TL data (provided in Phase II), to evaluate existing real world data collection sets and measure the resulting improvement on TL estimation to operator performance. The two-way transmission loss of active sonar detections (dependent on environmental state, bathymetry of ocean at the time and location of a given sonar transmission(s)) should be estimated to improve search mission planning. The detection TL estimates can then be used to reject clutter contacts that originated from areas of high TL.

Candidate algorithms will be assessed using datasets with known clutter to test the ability to reduce or remove clutter. Assessment will be based on known data sets with known "false alarms." Dummy data sets will be provided to selected Phase I companies for use during development.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by DoD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Security Service (DSS). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances, in order to perform on advanced phases of this project as set forth by DSS and NAVAIR in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advanced phases of this contract.

PHASE I: Research and investigate the suitability and feasibility of proposed TL estimation algorithm / software, enabling clutter reduction on simulated and unclassified data sets. Identify technological and reliability challenges of the design approach, and propose viable risk mitigation strategies.

PHASE II: Design and develop an engineering level (beta) robust TL estimation algorithm / software prototype based on the design from Phase I. Demonstrate the technique(s) by processing existing real world data collection sets and measure the resulting improvement in TL estimation to operator performance in accordance with the parameters in the Description.

PHASE III DUAL USE APPLICATIONS: Develop a production level version of the final robust TL estimation algorithm / software. Based on research, develop a timeline / plan / process for implementation of the algorithm / software and assist in transitioning the product to the Airborne ASW community through the Advanced Product Build (APB) process. Private Sector Commercial Potential: The developed technology has the potential to be useful for any system that can benefit from more accurate receiver and transmitter localization; benefitting industries may include seismic and oil exploration.

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KEYWORDS: Airborne ASW; Mission Planning Tools; ASW Operator Workload Reduction; Tactical Decision Aids; Transmission Loss; Estimation

TPOC-1: 301-757-5733

TPOC-2: 301-342-8234

TPOC-3: 301-757-3694

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N162-100 TITLE: Integrated Hybrid Structural Health Monitoring (SHM) System

TECHNOLOGY AREA(S): Air Platform, Electronics, Sensors

ACQUISITION PROGRAM: PMA-275, V-22 Osprey

OBJECTIVE: Develop an integrated, low-weight, hybrid Structural Health Monitoring (SHM) system that effectively utilizes fiber optic (FO) sensors and piezoelectric (PZT) actuators to capture damage data and corresponding structural response.

DESCRIPTION: Effective SHM systems must possess the ability to detect and track structural damage as well as monitor the actual environment and loading conditions the structure experiences. Two types of information are needed in order to accurately predict structural integrity: damage data and structural response. Current SHM systems utilize PZT actuators and FO sensors separately. PZT transducers are used to detect and track actual damage while FO sensors monitor loads and environmental parameters. Issues with current SHM systems utilizing PZTs include difficulties with cross communication between sensors and signal attenuation during long distance transmission. A hybrid system can avoid sensor cross communication by using different mechanisms for signal transmission. A hybrid diagnostic system that can capture damage and loads data by using PZT actuators to input controlled structural excitation and FO sensors to measure the corresponding structural response is sought.

An integrated systems approach is needed to develop a hybrid SHM system consisting of a hybrid sensor network, connectors, and data acquisition hardware/software integrated into a single unit that will take advantage of any commonality in electronic components. The FO and PZT sensors should be configured for placement onto the structure without structural degradation. The hybrid system will be evaluated on its damage detection, damage quantification, and static/dynamic loads monitoring capabilities. Emphasis will be placed on demonstration and integration of the SHM system on representative US Navy structural components in real world loading environments. The hardware and software for data acquisition and processing should be packaged as a single unit and must be as small and lightweight as possible. Integration with the current V-22 Vibration/Structural Life and Engine Diagnostics (VSLED) system is desired.

PHASE I: Develop and concept for, and demonstrate the technical feasibility of, an integrated hybrid SHM system that utilizes a FO/PZT sensor network to monitor loads and detect damage on structural components for the V-22 platform.

PHASE II: Develop a prototype of the complete hybrid SHM system and demonstrate the system's structural monitoring capabilities on a representative V-22 structural component/s.

PHASE III DUAL USE APPLICATIONS: Transition the integrated hybrid SHM system for implementation onto the V-22 platform, ensuring interoperability with the VSLED system. Transition will include ground and flight testing. Transition the developed SHM system to commercial aircraft industry. Private Sector Commercial Potential: Similar to Navy aircraft, commercial aircraft would benefit from a hybrid SHM system that accurately tracks aircraft use and damage data for structural components throughout the component's life. More precise fatigue/damage tracking can lead to reduced maintenance downtime and cost due to targeted, less frequent inspections and part replacement.

REFERENCES:
1. Wu, Z., Qing, X. P., & Chang, F. K. (2009). Damage detection for composite laminate plates with a distributed hybrid PZT/FBG sensor network. Journal of Intelligent Material Systems and Structures. Retrieved from http://jim.sagepub.com/content/20/9/1069

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239. Retrieved from http://www.sciencedirect.com/science/article/pii/S088832701300558X

KEYWORDS: Damage Detection; Load Monitoring; Maintenance Reduction; Structural Health Monitoring; Fiber Optic; Piezoelectric

TPOC-1: 301-757-2031

TPOC-2: 301-757-1314

TPOC-3: 301-342-8396

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N162-101 TITLE: Future Airborne Capability Environment (FACE) Transport Protocol Mediation and Integration

TECHNOLOGY AREA(S): Air Platform, Electronics, Information Systems

ACQUISITION PROGRAM: Joint Strike Fighter F-35 Lightning II Program

OBJECTIVE: Create a Graphical User Interface (GUI) tool for Future Airborne Capability Environment (FACE) transport protocol abstraction and platform data model integration that addresses the Navy's need to create a more efficient process for developing and integrating FACE Units of Portability (UoP), saving both time and money. The tool should be able to highlight disparities between protocols and messages, and data models and facilitate development of interoperability between these approaches.

DESCRIPTION: The Future Airborne Capability Environment (FACE) Technical Standard [1, 2, 3] describes a software Reference Architecture supporting several technical attributes including portability, reusability, flexibility, scalability, extensibility, conformance testability, modifiability, usability, interoperability, and integrate-ability. The FACE Technical Standard provides a framework upon which capabilities can be developed as part of a product line to enhance affordability and speed to fleet by reducing duplicative development efforts. The current FACE 2.0 and 2.1 Technical Standards consist of several layers which seek to abstract the concerns for data distribution and data understanding.

Systems integrated by one lead integrator are most often built in isolation from other systems, and to their own requirements resulting in differing or unique message protocols. This means that one system built to an Open Systems Architecture (OSA) standard may not be interoperable with a system built to the same standard by a different lead integrator. Previous attempts to solve the "Interoperability Problem" with OSA approaches have generally led to specifications of "common message" sets for systems to "speak" the same language but have resulted in little progress due to lack of common protocols and partial implementation of message sets. The FACE Data Architecture attempts to remedy this by requiring specific methods for documenting exchanged data but cases still exist where one system built from FACE conformant components cannot exchange information with another system built from FACE conformant components.

To help streamline the FACE system integration process, new software tools and techniques need to be developed to automate the process and visualize the complexity captured in the data model in a simple manner. Additionally, the standard practice of choosing a protocol for each system introduces additional challenges. To overcome this challenge, the Navy seeks an innovative technology to encapsulate protocols behind an abstraction interface and mediate between protocols allowing interoperability across differing technology innovations and message formats. If protocols become a discoverable, replaceable, pluggable feature, then many of the challenges with system to system interoperability can be solved. This technology could also benefit cyber-security as it would allow the ability to

randomly hop between protocols and provide a mechanism to make it harder to intercept network communications. Automation in mapping of disparate messages within FACE Platform Data Models is also desired to ensure interoperability between differing systems.

The functionality of the tools is not limited to these features and additional innovative functionality that assists in protocol mediation and data model integration is encouraged. The technologies resulting from this project should assist system integrators in mediating protocol, visualizing data models, identifying incompatibilities between data models, and combining message models to create or enhance a system.

PHASE I: Develop and demonstrate feasibility of a FACE Transport Protocol Mediation and Integration method for abstraction of protocols and integration of disparate platform data models. The identified methodology will provide the basis for tool prototype efforts during Phase II.

PHASE II: Based on Phase I effort, develop and demonstrate a FACE Transport Protocol Mediation and Integration prototype software tool for meeting the objectives outlined in the Description above. Test cases will be provided to the Phase II recipient and should be demonstrated in less than two hours at the end of Phase II.

PHASE III DUAL USE APPLICATIONS: Test and apply the developed FACE Transport Protocol Mediation and Integration tool(s) and techniques to a component of a Navy software system (e.g. a new capability). Finalize the prototype tool(s) for broader market utilization (military and commercial). Private Sector Commercial Potential: Many private sector industries developing aviation software supporting the new mandated FACE requirements could greatly benefit from this new technology. It should provide a key tool in modeling software in advance of full system software development. In addition, companies in the industrial and manufacturing sectors that use control systems as the backbone of their business processes (which is now becoming almost omnipresent) would also benefit (as demonstrated by the acceptance of FACE), as those systems are comprised of many diverse systems communicating to perform a common mission. In all cases, these systems have to be integrated in order to work correctly. The tools developed under this effort have potential benefit to these commercial needs.

REFERENCES:
1. FACE Technical Standard 2.0, https://www2.opengroup.org/ogsys/catalog/c137

2. FACE Technical Standard 2.1, https://www2.opengroup.org/ogsys/catalog/c145

3. FACE Shared Data Model 2.1,
https://www.opengroup.us/face/documents.php?action=show&dcat=31&gdid=17240

KEYWORDS: Integration; Architecture; FACE; Data Model; Portability; Abstraction

TPOC-1: 301-757-2720

TPOC-2: 301-757-6454

TPOC-3: 301-342-9124

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N162-102 TITLE: Next Generation Wind Measurement Technology

TECHNOLOGY AREA(S): Battlespace, Sensors

ACQUISITION PROGRAM: PMA 251 Aircraft Launch and Recovery Equipment

OBJECTIVE: Develop an innovative and low cost wind measurement solution capable of mapping wind speed and direction for the entire airspace for US Navy Air Capable Ships.

DESCRIPTION: The US Navy's air capable ships and aircraft carriers currently use a wind system to measure digital wind speed and direction information, such as crosswind, head wind, relative wind and true wind, to support air operations, navigation, tactical planning, combat, and firefighting by displaying this information to the ship's crew in multiple locations around the ship and to other systems. The current system requires an interface with the ship's navigation system, to calculate and display true wind. The current system is only capable of taking measurements at the two or three locations where sensors are installed. The displays are also required to display launch and recovery envelopes and overlay that on the wind data to provide situational awareness to the ship's crew to enable them to steer the ship within the approved envelope for aircraft operations.

Accurate wind data plays a critical role in Aircraft Launch and Recovery Equipment (ALRE) performance and pilot safety during the launch and recovery of aircraft. For instance, a wind difference of two knots can change the parameters for launching an aircraft off a carrier. The US Navy desires a new low cost solution to accurately measure wind data on the flight deck where aircraft are being launched or recovered as well as areas of interest out in space due to reports where the current wind sensors did not accurately represent the actual wind at the flight deck catapult. These anomalies were during higher sea states when the pitching deck created air turbulences that propagated across the deck. This added capability to map the entire airspace surrounding the ship would be beneficial to the fleet with regards to ordnance delivery, navigation, and the launch and recovery of aircraft, as well as the validation of computational fluid dynamics airwake turbulence models. Targeted production costs for each new system are $10K for a single standardized smart module and $3K for each wind sensor. This new solution should support all air capable ship classes and shore stations with a single standardized smart module capable of recognizing multiple configurations of sensors and displays. The architecture should be such that adding sensors and displays to the system can be accomplished quickly and easily with a self-configuration rather than a lengthy manual process.

An innovative approach is needed to identify the most cost effective methods to achieve the Navy's requirements. It is desired that the new system have the capability to self-calibrate to reduce maintenance costs and have built in tests to detect faults.

Previous research in this field has shown the following technology challenges that must be addressed:
- Compensation for ship motion
- Performance in all types of weather (including rain and fog)
- MIL-STD-810G environmental requirements and MIL-STD-461F Electromagnetic Interference requirements must be met
- Incorporation into existing ship structures
- Identifying the minimum number of sensors needed in order to keep installation costs at a minimum

The system's threshold requirements are as follows:
- Wind Speed Accuracy:
  - o 0-50 Knots: ±1.5 Knots
  - o 50.1-125 Knots: ±2.5 Knots
- Direction over entire sensor array:
  - o 0-360 degrees: ±2 degrees
- Sensor Range:
  - o 0-200 feet above water
  - o 0-200 feet directly above the ship
  - o 100 feet in front of and behind the ship
  - o Resolution of 10 feet
- Capable of operating with wind speeds up to 125 knots
- Capable of not dislocating from the ship due to wind up to 175 knots
- Maximum Sensor Dimensions:

o Cylinder with a diameter of 34” and height of 28”
o Objective Requirement: Cylinder with a diameter of 9” and height of 9”

PHASE I: Provide a conceptual design of the wind measurement system. Prove the feasibility of meeting the stated requirements through analysis and lab demonstrations. Identify specific strategies for minimizing system hardware costs.

PHASE II: Build a prototype system and demonstrate accuracy and coverage in a commercial wind tunnel. Demonstrate performance in poor weather by simulating rain/fog. Provide an estimate of per-unit cost with backup cost data, including parts/manufacturing. Provide a top-level failure analysis and service life estimate. Provide a top-level assessment of whether the system would pass MIL-STD-810G.

PHASE III DUAL USE APPLICATIONS: Further develop complete system architecture with sensing modules and displays optimized for the shipboard application including required environmental qualification and shock testing. Test prototype system to verify requirements established by NAVAIR. Provide production units for aircraft carriers and air capable ships. Private Sector Commercial Potential: Potential uses include private and commercial maritime environments, private and commercial air fields, meteorology, and monitoring potential sites for harvesting wind energy.

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1. Department of Defense. (1967). MIL-STD-461F, MILITARY STANDARD: ELECTROMAGNETIC INTERFERENCE CHARACTERISTICS REQUIREMENTS FOR EQUIPMENT. Retrieved from http://everyspec.com/MIL-STD/MIL-STD-0300-0499/MIL-STD-461_8678/

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KEYWORDS: Surface Aviation Ships; Wind Measurement System; Modular Design; Airwake Turbulence; Computational Fluid Dynamics; Reduced Total Ownership Costs

TPOC-1: 732-323-7310

TPOC-2: 732-323-2891

TPOC-3: 732-323-1874

TPOC-4: 301-342-9016

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N162-103 TITLE: Improved Volume Hologram Optical Elements

TECHNOLOGY AREA(S): Air Platform, Sensors

ACQUISITION PROGRAM: PMA-263, Navy and Marine Corps Small Tactical Unmanned Air Systems

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 5.4.c.(8) of the solicitation. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop an innovative solution to significantly improve the performance and manufacturability of Volume Hologram Optical Elements (VHOE) by improving diffraction efficiency, uniformity and reduce aberrations of the element as a whole.

DESCRIPTION: The concept of holography for creating "thin" mirrors, filters and lenses has been around for many decades [1, 2]. Early analysis showed that off-axis aberrations of Volume Hologram Optical Elements (VHOE) significantly exceed those of conventional optics [3]. Moderate quality, inexpensive (60% efficiency, ~$100) holographic gratings are readily available (Edmund Optics, Thorlabs) as well as special purpose, high quality gratings (High energy laser, HORIBA Scientific). However, optical elements such as spherical lenses and mirrors are not readily available for applications such as a compact telescope. The potential advantages of advancing the state of the art in VHOE are significant weight and space savings for large or complex optical systems, when compared to traditional glass element designs [4].

The objective of this SBIR topic is to advance the state of the art on four aspects of VHOE. The first (1) is diffraction efficiency across the element. Attention should be paid to individual hologram efficiency and packing density of multiple holograms (fill factor). The second (2) area is uniformity. Repeatable performance from hologram to hologram in wavelength, efficiency and diffraction angle will lead to good uniformity across the entire optical element. The third (3) area of improvement is in manufacturability [5]. Processes that lead to uniform material thickness, composition and curing and processes that reduce the total hologram write time should be investigated. Reducing production times from hours to minutes, for example, will negate many environmental factors and increase total production volume. Finally (4), an optical model of the VHOE should be developed so that optical system designers could incorporate VHOE's into the design process.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by DoD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Security Service (DSS). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances, in order to perform on advanced phases of this project as set forth by DSS and NAVAIR in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advanced phases of this contract.

PHASE I: Identify the technical hurdles to VHOE performance improvement and manufacturability. Develop and demonstrate the feasibility of the new technical approaches. Perform preliminary bench-top testing to verify performance of component or design.

PHASE II: Develop and demonstrate a working bench-top design. Sufficiently harden the bench-top design such that the element can be handled and mounted for testing and demonstration. Perform testing to include diffraction efficiency, uniformity and predicted versus actual diffraction angle across the element. Design and develop working prototype based on results of the hardened bench-top design. Complete preliminary design of VHOE incorporated into an optical system based on developed model of VHOE.

PHASE III DUAL USE APPLICATIONS: Complete prototype development and document the design. Prepare VHOE system designs and optical system units to be procured and tested/demonstrated in Navy systems. Support the Navy in testing and demonstrating the units and ensuring that they are production ready for use in Navy

Systems. Private Sector Commercial Potential: VHOE optical elements will have wide commercial applications such as compact, lightweight optical systems. For example, replacing a thick, curved surface optic with a thin plate VHOE will enable designs that were otherwise not possible due to size constraints.

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1. Collier, R. J. et al. (1971). Optical Holography, Academic Press, New York, 3-4

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5. Bruder, F., et al. (2015). Diffractive optics with high Bragg selectivity: volume holographic optical elements in Bayfol® HX photopolymer film, Proc. SPIE 9626

KEYWORDS: Volume Hologram; Grating Efficiency; Holographic Element; thin film lens; VHOE; optical systems

TPOC-1: 301-342-2034

TPOC-2: 301-342-0398

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N162-104 TITLE: High Capability Portable Foreign Object Debris (FOD) Removal System for Naval Aircraft

TECHNOLOGY AREA(S): Air Platform, Materials/Processes

ACQUISITION PROGRAM: PMA 257 AV-8B Harrier Program Office

OBJECTIVE: Develop a high capability, portable, foreign object debris (FOD) removal system to address a capability gap between larger systems and manual removal to positively impact foreign object damage rates and increase readiness, safety, reliability, and provide cost avoidance.

DESCRIPTION: The AV-8B currently has the highest FOD damage rate in the U.S. DoD inventory which incurs a cost of more than $100M per year in engine removal, rebuild, and reinstallation, as well as decreased readiness and safety. To date, NAVAIR has experienced more than eight Class 'A' mishaps in the AV-8B due to FOD, and an extremely high missed opportunity cost in terms of sorties and training. There are two envisioned uses for a FOD removal system: in the environment adjacent to the aircraft, and domestically within the aircraft. In terms of the environment adjacent to the aircraft, current FOD removal units (large trucks) are not suitable to remove FOD around and under aircraft, in the hangar, at the outdoor and indoor high power facilities, and while deployed to land-based airfields. In fact for land-based airfields, the current standard of FOD removal consists of "FOD walks" where personnel physically walk the flight line and visually observe the airfield surface. It can be at these obscured areas where FOD collects and can be ingested by the engine even under low power settings. Domestic object damage due to objects found inside the engine or aircraft can be just as damaging as FOD. Domestic FOD could be produced from maintenance action (e.g. small tools or bolts fall into enclosed engine compartment, or incorrect assembly leaves a bolt unsecured). At this time, manual procedures are used to collect potential domestic FOD. If domestic FOD is identified (e.g. dropped washers, nuts, etc.) and can't be recovered, the procedure to retrieve the object is to remove the engine from the aircraft and inspect potential locations until the domestic FOD is retrieved. A system

that can remove small sized FOD and have greater accessibility than manual methods is sought. The current mechanical and manual removal systems can remove “large FOD” (0.5 inches or more and weighing over 0.5 g). Test data has shown that objects smaller than “large FOD” can cause significant damage to rotating components of the engine. A FOD removal system that maintains performance of the current systems but can also remove objects smaller than current system capability is envisioned. A successful development effort will result in closing a significant FOD removal gap currently present in the AV-8B and other legacy platforms.

An innovative modular system capable of providing a flexible solution for FOD removal, both on the flight line and in aircraft compartments where FOD collections are needed. The desired size of FOD for removal should be smaller than the current sizes and mass given above. Units will need to be modular with envisioned size being as large as a hand cart for large areas and have the appropriate attachments for confined areas. In all contexts, a single person should be able to operate the system, even when diving into engine inlet necessary. In terms of power draw, the unit should able to be converted from gas powered engine for field use, to 115/220V/3-Phase electrical power for enclosed spaces to maximize flexibility and portability. The units would also need to be non-reactive in the normal aircraft hangar operating environment in-and-around the engine bay and inside the aircraft to ensure safety of personnel and equipment. Such environments can reach high temperatures with gas fumes or other combustible debris, in proximity of areas to be accessed. These units would also need to be robust enough and able to be used in austere sites where aircraft operate away from airfields with mature anti-FOD programs and facilities. Units should be able to be used at unprepared airfields which present frequent FOD hazards to the fleet. No system currently exists that is capable of the modularity and flexibility in terms of power source and environmental considerations. Collected FOD should be able to be analyzed in their as-discovered condition (not demolished) so that it can be identified and documented against any known FOD.

Developing, maturing and implementing an innovative vacuum system will result in a comprehensive FOD mitigation that will help Marines and Navy personnel achieve the goal of reducing the FOD rate by 50% (1.7 incidents per 1000 flight hours (FHs) to 0.8 incidents per 1000 FHs). This will result in a cost avoidance of approximately $50M annually. It is anticipated that approximately 8 Ready Based Aircraft (RBA) will be added to flight availability annually due to reduced maintenance time. The development of new attachments and techniques, tactics and procedures (TTPs) with the units will also reduce the probability of mishap due to internal FOD by giving the maintainers the ability to remove debris with the engine and other components on wing.

Coordination with aircraft and engine original equipment manufacturers (OEMs) is strongly recommended, but is not required.

PHASE I: Design and demonstrate the feasibility of a foreign object debris removal system which can be used in-and-around the aircraft and in the engine bay areas in accordance with the parameters outlined in the Description. Feasibility of FOD removal both in confined areas and non-confined areas must be demonstrated.

PHASE II: Further develop the foreign object debris removal system prototype as well as AV-8B aviation-specific prototype attachments and demonstrate their ability to clean FOD such as what might be found in engine bays, under the ejection seats, under the aircraft and its capability to retrieve and/or remove dropped tools, fasteners, and similar material.

PHASE III DUAL USE APPLICATIONS: Complete any final design modifications and provide needed support to fully transition and integrate the developed foreign object removal system with custom attachments for commercial and Navy applications, and provide training to users. Private Sector Commercial Potential: Civilian and other aviation applicability is limitless but specifically could assist any sensitive maintenance or rebuild facility where FOD or debris is a problem. All aircraft, civilian or military, have an associate FOD cost and if utilized properly, that cost can be driven down by tailored FOD-mitigation technologies such that these units could provide.

REFERENCES:
1. Airport Foreign Object Debris (FOD) Management, Advisory Circular. (2010). U. S. Department of Transportation and the Federal Aviation Administration (FAA), http://www.faa.gov/documentLibrary/media/Advisory_Circular/150_5210_24.pdf

2. Foreign Object Debris and Foreign Object Damage (FOD) Prevention for Aviation Maintenance & Manufacturing, 13 November 2007, http://www.rotor.org/portals/1/committee/fod.doc

KEYWORDS: FOD; Safety; Maintenance; Cost Avoidance; Readiness; Durability

TPOC-1: 301-757-9490

TPOC-2: 301-757-0472

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N162-105 TITLE: Real Time Gas Turbine Engine Particulate Ingestion Sensor for Particle Size and Composition

TECHNOLOGY AREA(S): Electronics, Sensors

ACQUISITION PROGRAM: PMA-275 V-22 Osprey

OBJECTIVE: Develop an innovative aircraft/engine sensor or sensor system that is capable of determining the composition (with respect to Calcium, Magnesium, Aluminum, and Silicon (CMAS) compounds and other reactive media) as well as characterize the size and concentration of ingested sand and dust particulate.

DESCRIPTION: Modern military and commercial gas turbine engines are subject to increased durability, performance, and safety issues when operating in austere environments where significant quantities of sand, volcanic ash and dust are present and can be ingested into the engines. These environments include desert regions as well as previously active/currently active volcanic areas. Military studies of turbine engine sand, dust, and ash ingestion have shown that certain constituents, typically those containing CMAS compound minerals and/or Chlorides and Sulfates, are particularly detrimental to engine turbine components. These compound minerals, known as 'reactive media', have one or more physical or chemical characteristics including but not limited to size, mass, mineralogy and chemical composition that drive the phase of the media to change, from solid to semi-solid (partially molten) or liquid (molten), as they pass through the combustion section of the engine allowing them to adhere to various turbine components including but not limited to stator vanes, rotor blades and shrouds. Reactive media has been found to have significant and rapid detrimental effects on engine performance, durability and operability. Currently, there are no aircraft/engine sensors that can provide the information needed to understand the specific composition, size and concentration of ingested reactive material, which is a key factor in determining if reactive media is being ingested into the engine.

The sensor system developed should implement a technique for detecting, recording, and outputting the debris properties so the information can be leveraged by the existing engine FADEC (Full Authority Digital Engine Control) and/or aircraft mission computers in near real-time. This will allow for crew notification and the employment of advanced self-protection techniques.

Coordination with original equipment manufacturers (OEMs) is strongly recommended, but not required. A strong coordination with selected-engine OEM and/or multiple designated second-party partners, especially relating to the signal data bus transmission scheme, data acquisition and processing approach and specific assemble interface to the aircraft/engine would ensure the relevance of proposed methods to modern gas turbine engines and rotorcraft.

Sensor system should detect the size, concentration and presence of, at a minimum, the following materials:
• Calcium
• Magnesium
• Aluminum
• Silicon

• Chlorides
• Sulfates

Integration Requirements:
• The sensor system should be designed to integrate with multiple engines/aircraft with minor modifications. Possible locations include, but are not limited to: aircraft inlet, engine inlet, engine bypass, engine gas path.
• The sensor system should be designed to interface with an engine FADEC and/or aircraft mission computers (or equivalent commercial systems) using existing communication technology.
• The sensor system should not adversely affect airflow into or inside the engine.

Validation Requirements:
• Sensor system functionality will be validated upon successful Phase II effort, using a T700-GE-401C Turboshaft engine on an uninstalled test cell. The media for the validation will be baseline commercially available specification sands and AFRL-03 sand.

PHASE I: Design and demonstrate the feasibility of a sensor system to determine airborne debris size distribution, concentration and composition. Provide technical details on how the sensor system will capture, analyze and communicate its findings to the aircraft systems. A prototype sensor system may be demonstrated in bench tests if feasible.

PHASE II: Produce a detailed design(s) and prototype the assembly. Perform bench level testing on the sensor system to demonstrate effectiveness. Document all technical hardware and software specifications for the system in the Phase II final report.

PHASE III DUAL USE APPLICATIONS: Finalize sensor system integration with major DoD end users and engine manufacturers and demonstrate the developed sensor system in a relevant engine/aircraft environment. Support the Navy for test and validation to certify and qualify the system for Navy use. Private Sector Commercial Potential: Sand, dust, and ash ingestion is an emerging issue for commercial jet aircraft. One example includes the 2010 Iceland volcanic eruption, which resulted in closure of the airspace of much of northern Europe as a result of the detrimental effect of volcanic ash on commercial airliner engines. Commercial aviation is also subjected to dust/sand ingestion while operating in desert locations. It is expected that the hardware (and software) developed under this solicitation would have direct application for the detection of volcanic dust into commercial airline engines. The technology could provide crew indications to mitigate reactive debris ingestion, thus limiting the damage and repairs that are incurred.

REFERENCES:
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http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20130013612.pdf

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KEYWORDS: CMAS; Gas Turbine Engines; particle separation; Sand dust and ash ingestion; optical and laser sensors; Reactive Media

TPOC-1: 301-757-0513

TPOC-2: 301-757-8767

TPOC-3: 301-757-2348

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N162-106 TITLE: Advanced High Speed Bus Technologies for Units Under Test (UUT), Test and Evaluation

TECHNOLOGY AREA(S): Electronics, Information Systems, Materials/Processes

ACQUISITION PROGRAM: PMA 260, Aviation Support Equipment

OBJECTIVE: Develop innovative test methods and associated tools required to support the advanced testing requirements of emerging high-speed bus technologies that are required for design-for-test as well as operational testing.

DESCRIPTION: Current state-of-the-art test tools handle conventional data buses, but cannot address the testing needs of new, high speed, data buses that are being incorporated in the latest aircraft enhancements. Next-generation Units Under Test (UUTs) are designed with high-throughput buses ranging from 100 Mbps to 1500 Mbps, and utilize various new data buses (e.g. Firewire, RS-422, Wi-Fi, SATA, SMPTE Video). This drives a need for faster digital communication buses in Automatic Test Equipment (ATE) to facilitate testing, file upload and download, and other UUT interactions.

The methods and tools developed will aid in the support of state-of-the-art bus technologies in the fleet, and also ensure the integrity, quality, and reliability of the signals and data communication associated with the buses. This effort should leverage the current Navy Automatic Test System (ATS) environments, and industry standards to support electronics maintenance.

High speed data buses are a new technology being introduced into Navy avionics, as well as electronic equipment in other Services. Solutions to fully test this new technology are required for Navy ATS. The technologies required will have a direct impact on testing associated with both design and operation of Units Under Test (UUTs) employing high speed communication interfacing and busing. This is evident in the need for standards in the DoD ATS Framework Integrated Product Team (IPT)'s key element UUT Device Interfaces (UDI). The UDI element recognizes the requirements for testing complex forms of data communication, and requires industry standards to ensure an open architecture approach is integrated in the resulting technologies. These technologies involve extremely high speed data rates, complex timing and synchronization, and high speed multiplexing, all of which require parameters that are capable of insuring signal integrity. Some of these parameters involve statistical measurements, bit error rates, and complex signal to noise and distortion measurements. Current and conventional test methods are not capable of achieving the degree of testing quality necessary to ensure the proper performance of these UUTs and maintaining the data integrity for high speed net-centric information exchanges.

In order to ensure consistency of approaches and tools, industry standards related to signals associated with advanced bussing should be considered, such as the Automatic Test Markup Language (IEEE-1671, ATML). In working with the current industry standards, deficiencies might be found. In this case, the effort would involve identifying/suggesting new standards, and/or modifications to existing standards, which would help ensure a consistent, open system, approach across DoD systems.

To achieve these objectives, a set of tools are required that employ standardized technologies associated with digital radio, wireless communication, switching, fiber optics, and networking, which are being employed in existing as well as new UUTs. These tools should encompass industry standard signal libraries (such as IEEE-1641), test descriptions describing parameterized test methods, and performance verification for communication with devices that have highly complex inputs and outputs. The tools need to configure test instrumentation such as waveform generators, digitizers, oscillators, up and down converters, bus analyzers, and high speed digital generators to support the development of the signals / methods required. These test and evaluation tools are expected to significantly reduce the test cost and foot print of support items, and enhance Test Program Set (TPS) rehost.

PHASE I: Design and demonstrate a proof of concept signal model necessary to support described technologies. Define a set of tools that utilize the signal model and show how they can be utilized together to support high speed bust testing. If noticed during development, make note of applicability of existing industry standards and the possible need to enhance these standards, or create new standards.

PHASE II: Further develop the Phase I products into a usable library of models and tools to support high speed bus testing. Evaluate and demonstrate the prototype tool using one of the members of the DoD family of testers, such as Navy Consolidated Automated Support System (CASS), Air Force Versatile Depot Automatic Test System (VDATS), and Army Integrated Family of Test Equipment (IFTE). Access to these testers will be provided at DoD labs or maintenance facilities as required and as available at no cost to the small business. Perform analysis of the models and tools to determine their ability to support high speed bus testing. Ensure the models and tools are consistent with industry standards, such as those defined by IEEE.

PHASE III DUAL USE APPLICATIONS: Finalize and deliver models and tools suitable for use on ATS across the DoD. Transition the technology to appropriate test platforms. Private Sector Commercial Potential: Bus testing is a generic technology used across DoD and industry. This proposal has direct impact to all DoD Services, and could be transitioned to various commercial industries.

REFERENCES:

1. IEEE STD 1671-2010, IEEE Standard for Automatic Test Markup Language (ATML for Exchanging Automatic Test Equipment and Test Information via XML (2011).
http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=5706290&url=http%3A%2F%2Fieeexplore.ieee.org%2Fstamp%2Fstamp.jsp%3Ftp%3D%26arnumber%3D5706290

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6. DoD ATS Executive Directorate website. http://www.acq.osd.mil/ats/

KEYWORDS: Automatic Test Equipment; Test Program; Bus Technologies; Electronics Maintenance; Data Communication; Digital Signals

TPOC-1: 732-323-4877

TPOC-2: 732-323-1251

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N162-107 TITLE: Improve Proton Exchange Membrane (PEM) Electrocatalysts

TECHNOLOGY AREA(S): Materials/Processes

ACQUISITION PROGRAM: PMS450, VIRGINIA Class Submarine Program Office

OBJECTIVE: Develop advanced non-noble metal PEM electrocatalysts and engineered nanostructures to improve submarine oxygen generators and significantly reduce cost.

DESCRIPTION: Oxygen is generated onboard submarines utilizing electrolysis conducted within a stack of Proton Exchange Membranes (PEM) cells known as a cell stack. Within the electrolysis cell stack, the PEM material is a subcomponent of the Membrane Electrode Assembly (MEA) and it is within this MEA that electrocatalysts are employed to encourage both the oxidation and reduction processes. The electrocatalysts currently used are noble metal catalysts, which add significant cost to the submarine electrolysis cell stack valued at $1M each.

Noble metals are also known as strategic metals as defined by the National Research Council and are often referred to as such in electrolysis studies. At an estimated 25% of the cost of an electrolysis cell stack, the MEA is a prime candidate for catalytic improvement with significant and measureable cost benefit. Recently reported basic research (references 1, 2, and 3) discusses the successful use of a non-noble metal catalyst for the electrolysis. The reported successes utilizing molybdenum phosphide (MoP) and molybdenum phosphide with a phosphosulfide surface (MoP/S) are extremely promising and directly applicable to PEM electrolyzers, however additional research is required to evaluate how these materials or similar non-noble metal catalysts perform at high current densities of approximately 1000 amps per square foot (ASF). By eliminating or reducing the use of costly precious metals as the electrocatalysts, the Navy will achieve significant cost reductions in acquisition and maintenance to the order of roughly $200,000 per electrolysis stack.

Additionally, the development of an improved and novel MEA such as an engineered nanostructure to enhance activity (references 4 and 5), will achieve a reduction in the catalyst loading, which will also result in significant cost reductions by reducing the amount of catalyst required. PEM fuel cells and the PEM electrolysis cell stacks have unique requirements. They have already achieved loading reductions of at least an order of magnitude below the current submarine PEM electrolysis cell stack design from on the order of 1 mg of catalyst / cm^2 of active area to on the order of 0.1 mg of catalyst / cm^2 of active areas. These unique requirements include alternative catalyst morphologies and compositions, support characteristics such as wetting properties and the porosity for gas and fluid transport, and deposition methods to form a highly active and stable electrode at low catalyst loading.

Current submarine electrolysis cell stacks are capable of operating at oxygen generation rates of 225 standard cubic feet per hour (SCFH) and a current density of 1000 ASF which are required to operate for a minimum of 30,000 hours prior to failure. Future submarine oxygen generators currently in development have these same operational requirements and will utilize a PEM electrolysis cell stack. It is critical to the Navy to invest in advancements in technology to realize benefits from potential performance improvements, to reduce the cost, and improve affordability of a known high dollar acquisition and maintenance component. Qualification of a new cell stack for submarine use would most likely involve shock/vibration testing and a 2,000-hour endurance test or equivalent testing to show that the cell stack will last the required 30,000 hours of operation.

The target platform for implementation of these improvements would be on all current and planned VIRGINIA Class submarines. Additionally, these improvements would be beneficial to the PEM electrolyzer on Ohio Replacement and may even stand to benefit the PEM electrolyzer on SEAWOLF and OHIO Class submarines. The objective is to meet current performance requirements while achieving a reduction in acquisition cost by $200K per electrolysis cell stack, which will have additional affordability benefits to the Navy's operation and maintenance costs on the order of magnitude of $10M's.

PHASE I: The company will develop a concept that will demonstrate and report on achieved and anticipated optimized performance of non-noble metal electrocatalysts as compared to noble metal electrocatalysts and improved or novel MEA structures capable of operating in the described submarine operational environment. The company will perform modeling and simulation to provide the initial feasibility assessment of the concept performance. The Phase I Option if exercised, will include the initial layout and capabilities description to build the MEA structures.

PHASE II: Based on the results of Phase I and the Phase II Statement of Work (SOW), the company will develop and build a prototype 4-cell stack incorporating the improved electrocatalyst and novel MEA structures developed in Phase I. This prototype should be capable of operating at equivalent current density of 1000 ASF and at an equivalent oxygen generation rate of 225 SCFH. Results from the prototype 4-cell stack testing will be compared to a 4-cell stack utilizing a noble metal electrocatalyst representative to those currently deployed on VIRGINIA Class submarines. The company will deliver the prototype at the end of the Phase II to the Navy.

PHASE III DUAL USE APPLICATIONS: The company will design and develop a process for manufacturing a 225 SCFH electrolysis cell stack which will operate in the VIRGINIA Class PEM electrolyzers capable of meeting the acquisition needs and the future maintenance requirements for potentially all other Navy submarine PEM electrolyzers. Depending on the need and similarity to the existing cell stack, the improved PEM electrolysis cell stack would optimally be qualified for submarine use as a standalone component as part of a submarine electrolyzer first article unit, or strictly by analysis, pending qualification. Private Sector Commercial Potential: This area of research and technologic improvements has direct importance to commercial PEM electrolyzers and PEM fuel cells. PEM electrolyzers and PEM fuel cells compete in markets such as automotive propulsion as an alternative to gasoline-powered engines (alternative energy source), supplying power to our nation's electrical grid (energy efficiency), and even use as a clean water-splitting energy source as an alternative to fossil fuel-based power generation (alternative energy source). Adaptions of these improvements are also relevant for use in solar photo electrochemical cells in energy generation (alternative energy source) and all other market in which solar cells compete. All of these applications rely on the same limited noble metal electrocatalysts so all improvements will uniformly benefit all of these applications.

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KEYWORDS: Non-noble metal catalyst; electrocatalyst for oxygen generation; electrochemical; hydrogen evolution; proton exchange membrane; fuel cell molybdenum phosphide with a phosphosulfide surface

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Questions may also be submitted through DoD SBIR/STTR SITIS website.

N162-108 TITLE: Unmanned Surface Vehicle (USV)-Mounted Acoustic Generator

TECHNOLOGY AREA(S): Battlespace, Electronics, Sensors

ACQUISITION PROGRAM: PMS406, Unmanned Maritime Systems Program Office

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 5.4.c.(8) of the solicitation. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop an innovative acoustic generator capable of being mounted to and operating from an Unmanned Surface Vehicle (USV).

DESCRIPTION: Many Navy systems are being developed that use Fleet-class USVs. These USV-based systems require lighter weight, lower drag, and smaller footprint products than their legacy counterparts (Ref. 1). There are currently a number of technology development efforts for various types of sensors and emitters that will be suitable for integration with a Fleet-class (11-meter) USV. However, many of these sensors and emitters are towed systems which result in increased drag and fuel consumption, as well as reduced capability in shallow water and constrained waterways (Ref. 2). By eliminating the towed system from the USV, a reduction in towed system drag on the craft will result in increased endurance for the system while operating at the same speed. This will increase system capability by potentially increasing the coverage rate and allowing its use in shallower water and constrained waterways than current towed systems.

The US Navy is seeking an innovative acoustic source capable of generating a broad range of outputs that would be mounted either above the waterline or within the hull and structure of an existing Navy USV. However, if a solution were sub-surface, the acoustic generator would be stowed above the waterline or within the USV hull-form until performing operations. The system must be lightweight (less than 200lb); contained in a small-volume (less than 30cft); require minimal electrical or propulsion power (less than 10kw electrical power; Propulsive Power 90hp); have a high acoustical power radiation (between 175-185dB, each over frequency range of 10Hz to 5kHz); and mitigate the effects of craft speed and its variations (be speed independent). The acoustic generator will be

autonomously activated by the USV's central command and control.

By eliminating towed items, the towed system drag to the Unmanned Surface Vehicle (USV) can be reduced by up to 50%. That savings will result in a lower fuel burn rate and an increased endurance. An increase in endurance will increase the capability of the USV and multiple payloads can be carried on the USV for multiple mission sets. Dragging these systems through the seawater increase the life-cycle cost based on the maintenance associated with the seawater environment. By removing the acoustic source from the water, the mean time before maintenance will increase which will reduce the life-cycle cost of these systems.

PHASE I: The company will develop a concept for an acoustic generator meeting the requirements in the description. The company will identify the technical feasibility of the proposed concept and demonstrate the concept through modeling, analysis, and/or bench top experimentation where appropriate. The results will be used to determine the feasibility of the concept through effectiveness modeling for an innovative acoustic generator that meets the needs of the Navy. The Phase I final report shall capture the technical feasibility and economic viability for the proposed concept. The Phase I Option, if awarded, should include the initial description and capabilities to build the unit in Phase II.

PHASE II: The company will develop and fabricate a prototype acoustic generator based on the Phase I work and Phase II Statement of Work (SOW) for demonstration and characterization of key parameters and objectives. At the end of Phase II, prototype acoustic generator components shall be tested according to requirements set forth in the description. Based on lessons learned in Phase II through the prototype demonstration, a substantially complete design of the acoustic generator should be completed and delivered.

PHASE III DUAL USE APPLICATIONS: The company will be expected to support the Navy in transitioning the technology for Navy use. The final acoustic generator product will need to conform to requirements as described in the description and expected to pass Navy qualification testing. A full-scale prototype will be operationally tested and certified by the Navy to be integrated with an USV for further performance testing. Private Sector Commercial Potential: Developed technologies may be of some potential benefit/use to the petroleum, water rescue/salvage, and commercial fishing industries.

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2. US Coast Guard. Boat Crew Seamanship Manual – Chapter 17: Towing. Washington, DC: Department of Homeland Security, 2003, pp17.1-17.60; http://www.uscg.mil/directives/cim/16000-16999/cim_16114_5c.pdf

KEYWORDS: Non-towed acoustic generator; low-drag; unmanned surface vehicle; acoustic frequency and amplitude; endurance; autonomous

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Questions may also be submitted through DoD SBIR/STTR SITIS website.

N162-109 TITLE: Medium Voltage Direct Current (MVDC) Casualty Power

TECHNOLOGY AREA(S): Ground/Sea Vehicles

ACQUISITION PROGRAM: PMS 320 - Advanced Surface Machinery Systems

OBJECTIVE: Develop a lightweight and affordable capability to restore Medium Voltage Direct Current (MVDC) power to zones isolated from generation by damage, to zones between the source and the rest of the system. Portable elements of the capability shall be light enough to be safely handled by a team composed of sailors of size and strength ranging from the 5th percentile female to the 95th percentile male. For a given ship design, the decision on whether to install an MVDC casualty power system will be based on risk and a comparison of the cost and system weight of the MVDC casualty power to the cost and system weight of effectively armoring and protecting the port and starboard buses from damage within a zone.

DESCRIPTION: Casualty power has typically been used to provide loads to specific 440 volt (60 Hz. alternating current) VAC loads through a network of portable cables and through-bulkhead connectors. The system currently used is power limited and very labor intensive.

Future combatant designs are anticipated to implement zonal survivability and selective compartment survivability to the greatest extent practical (ref #1). One challenge is that for small warships, power generation is not generally located in the forward or aft zone due to the inability to locate intakes and uptakes. Furthermore, the beam of smaller warships may not be sufficient to ensure both port and starboard buses in a two-bus system will survive. In these cases, zonal survivability must consider both vulnerability and recoverability. A casualty power system is the means for recovering power to a zone that may be isolated by generation due to battle damage in a zone between it and the zone with generation. A capable casualty power system will enable the crew to recover power to undamaged zones following battle damage.

The envisioned solution would not depend on cable or equipment surviving in the damaged zone, but would employ equipment permanently installed in zones on either side of a damaged zone and portable conductors that the crew could use to "jumper" across the damaged zone. Several redundant portable conductors would be stored in different zones of the ship to ensure a sufficient number of portable conductors survive the battle damage. The casualty power system is intended for MVDC systems (ref #2) with voltages between 6 kV and 18 kV and rated for a current between 300 and 500 amps. The casualty power system should interface (via a mechanism such as coded cable connectors, auxiliary conductors or fiber optic cables) with the machinery control system to enable detection of the connectivity and to limit current to below the system current rating. The envisioned solution should be safe to rig and operate within 30 minutes of the ship's power system experiencing damage. Minimizing system overall cost and weight are key factors.

A capable Casualty Power System as described here enables recovering power to undamaged zones following battle damage. The alternative would be to either accept the operational risk of losing the capability provided by systems within the unpowered-undamaged zone or by heavily armoring and protecting each of the longitudinal electrical distribution busses (at great cost and additional weight) to enhance their ability to survive battle damage. This would reduce the acquisition costs due to not having to procure new assets to replace those that were not repairable after sustaining damage.

No known research exists on MVDC casualty power systems.

PHASE I: In Phase I, the company must provide a concept for a MVDC Casualty Power system. This concept shall be analyzed to estimate its cost, weight, volume requirements, and the time required by the crew to deploy the system. The company shall perform a hazard analysis and ensure the concept is safe to deploy and operate. The company shall identify technical risks of their concept. In the Phase I Option if exercised, companies will produce draft specifications and a capabilities description for the final components of the system.

PHASE II: In Phase II, the company shall produce a prototype system for testing and evaluation based on the results of Phase I and the Phase II Statement of Work (SOW). This prototype will be delivered at the end of the Phase II. The company shall conduct a test and evaluation program to address the technical risks of operating and integrating

the system onboard. This prototype system shall have the full electrical and control system functionality. The company shall update the specifications for the final components of the system. The company shall develop a design practices and criteria manual for the design and installation of the casualty power system for a surface combatant.

PHASE III DUAL USE APPLICATIONS: The company will support the Navy in transitioning the technology to Navy use. The company shall produce first-articles using the specifications for the final components of the system. The company shall conduct first-article testing and any other testing as detailed in the specification for each of the components. The company shall design, construct, and demonstrate a casualty power system using the specifications and the design practices and criteria manual developed in Phase II. The contractor shall update the specifications and design practices and criteria manual to reflect lessons learned. Private Sector Commercial Potential: While casualty power systems generally do not have a direct application to commercial systems, some industries do employ temporary power systems where similar technology may apply. Examples include the mining industry, tunneling machines, and oil industry.

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KEYWORDS: Casualty Power System; portable power cables; temporary power systems; power terminals; medium voltage DC power cables; medium voltage DC power connectors

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Questions may also be submitted through DoD SBIR/STTR SITIS website.

N162-110 TITLE: Hermetically Sealed and Orientation-Independent Vacuum Gauge for Monitoring Deep Vacuum

TECHNOLOGY AREA(S): Ground/Sea Vehicles

ACQUISITION PROGRAM: PMS320, Electric Ships Office; PMS501 Littoral Combat Ship Program Office

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 5.4.c.(8) of the solicitation. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop an innovative hermetically sealed, orientation independent vacuum measurement system capable of measuring vacuum levels between 1 Microtorr to 1520 Torr (~2 atm).

DESCRIPTION: Future naval power systems are trending towards a fully integrated power system, which will leverage installed electrical generation to meet the high power demand of future loads. The electric propulsion loads fall within the range of 20-80 MW. Distributing this level of power requires a high power density solution to minimize space and weight. High temperature superconductor (HTS) technology including cables, motors, and generators, is one potential solution. In addition to power applications, HTS is an ideal candidate for degaussing applications due to the high current density with less weight and space. Successful application of this technology requires minimizing heat transfer into the cryogenic spaces where the HTS material resides.

HTS systems utilize a vacuum space in conjunction with multi-layer insulation (MLI) to minimize the heat transfer into cryogenic space. The vacuum degrades over time due to outgassing of materials. As the vacuum degrades, the performance of MLI decreases and higher heat leak into the cryogenic system occurs. Either the result is the inability to maintain the cryogenic environment thereby destroying the superconducting state; or the cryogenic system output needs to be increased to keep up with the higher heat load. A deep vacuum of approximately 1 Microtorr (1E-6 Torr) is an ideal vacuum level; however, in practice, warm vacuum levels approximately 1 Millitorr (1E-3 Torr) are acceptable.

Currently, the only commercially available hermetically sealed vacuum gauges that meet system requirements are spinning rotor gauges which have orientation sensitivity. This orientation sensitivity is problematic when installed on an HTS cable since the final installed orientation is generally not known at the time of manufacture. If the rotor gauge is not in the proper orientation in the final installed position, the vacuum gauge becomes inoperable. Non-orientation sensitive solutions are available, but are not hermetically sealed. Maintaining a high vacuum level is dependent on the exclusion of contaminants within the system, and elimination of sources of vacuum leaks. For these reasons, the Navy needs a hermetically sealed, non-orientation sensitive solution.

The Navy has been developing a high temperature superconducting degaussing system (HTS DG) that has a lower system cost, decreases weight and volume requirements, and offers lower power requirements as compared to a traditional copper-based degaussing system. This topic seeks to develop a component that replaces a current vacuum gauge that has significant limitations for use in the field. The orientation sensitivity of the existing gauge results in inoperability on an installed HTS DG cable leaving vacuum levels in the cryostats unknown. The component developed through this topic will have utility in HTS Motors, generators, power cables, and any other vacuum insulated system that requires monitoring deep vacuum levels.

The objective of this topic is to develop an innovative vacuum sensor capable of measuring vacuum in the range of 1-Microtorr to 1520 Torr (~2 atm) while being insensitive to installation orientation. High precision vacuum readings are not required and an error of 10-20% of the reading is acceptable. The sensor must be rugged enough to be used in a shipboard environment and must meet all qualification requirements including shock and vibration, which will be tested by the Navy. Two potential approaches to using these gauges on the ship are as either an active part of the HTS system that continuously monitor the vacuum or the gauge may be used for periodic checks, similar to the current gauges. Use as an active part of the system is preferable solution as it has the potential to reduce manning requirements for periodic vacuum level evaluation. The final vacuum sensor is expected to be low cost ($100-$500), compact in size (3” x 2”dia), and have a service life of 30 years.

PHASE I: The small business will develop a concept for a hermetically sealed, orientation independent vacuum measurement system. Feasibility of an innovative vacuum sensor that meets the needs of the Navy as defined in the description will be demonstrated by modeling and simulation. The company will identify the technical feasibility of the proposed concept and demonstrate the concept through modeling, analysis, and/or bench top experimentation where appropriate. The Phase I final report shall capture the technical feasibility and economic viability for the proposed concept. The Phase I Option, if awarded, should include the initial description and capabilities to build the unit in Phase II.

PHASE II: The small business will develop and fabricate a prototype vacuum gauge based on the Phase I work and Phase II Statement of Work (SOW) for demonstration and characterization of key parameters and objectives. At the

end of Phase II, a prototype vacuum sensor shall be delivered to the Navy for further performance testing. Based on lessons learned in Phase II through the prototype demonstration, a substantially complete design of a vacuum sensor should be completed that would be expected to pass Navy qualification testing including shock and vibration.

PHASE III DUAL USE APPLICATIONS: The small business will be expected to support the Navy in transitioning the technology for Navy use onboard ships. This includes teaming with appropriate industry partners to provide a fully qualified vacuum sensor for integration and use in HTS systems for degaussing and power distribution. Private Sector Commercial Potential: Vacuum sensors have wide spread industrial and academic use in cryogenics, superconductivity, and the semi-conductor industry making it broadly applicable to the commercial world.

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http://everyspec.com/MIL-SPECS/MIL-SPECS-MIL-S/MIL-S-901D_14581/

KEYWORDS: HTS; superconductivity; hermetic sealed vacuum gauge; orientation independent vacuum gauge; vacuum maintenance and measurement; vacuum spinning rotor gauge

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Questions may also be submitted through DoD SBIR/STTR SITIS website.

N162-111 TITLE: Naval Special Warfare Ultra High Frequency (UHF) Satellite Communications (SATCOM) Low Elevation Angle Antenna

TECHNOLOGY AREA(S): Battlespace, Electronics, Sensors

ACQUISITION PROGRAM: PMS340, Naval Special Warfare Program Office (Acquisition Program: SDV, SWCS) USSOCOM (PEO-M) DCS

OBJECTIVE: Develop a UHF SATCOM antenna with low elevation angle coverage to meet the operational needs of Naval Special Warfare.

DESCRIPTION: Naval Special Warfare (NSW) Forces employ the use of undersea mobility platforms including the in-service SEAL Delivery Vehicles (SDV) and two additional platforms that are currently under development. All of these platforms include the capability to communicate via UHF SATCOM. The current UHF SATCOM antenna used in the SDV fleet provides usable coverage only in the upward looking direction at elevation look angles greater than 45 degrees above the horizon. The SDV program office seeks the development of a Low Elevation Angle UHF Mast Antenna that will be used for UHF SATCOM communication on NSW Submersibles including the SDV and Dry Combat Submersibles (DCS). The antenna will be mast-mounted and will be a modular replacement with the existing UHF SATCOM antenna in use. It should be capable of being submerged in seawater to 125m. Prior to use, the antenna will be raised above the water line.

A mathematical approach is described to determine the required look angles (Ref. 1) to point an antenna to a geostationary communication satellite such as the Ultra High Frequency Follow-on (UFO) Satellite, which is used for military UHF SATCOM. Earth coverage analysis and simulation is described (Ref. 2) along with the difficulties of maintaining coverage with satellites for communication.

Physical Characteristics:

The existing UHF SATCOM antenna in use is housed in a government designed cylindrical radome made from G-10/FR4 fiberglass. The low angle antenna should be developed to fit within this exiting radome if possible. Novel and innovative ideas will be considered that exceed the existing radome envelope if they show promise for operating in a submerged marine environment and for successful integration into an NSW undersea mobility platform. This effort will reduce the life-cycle cost by 20-30% of future undersea mobility platforms through the development of a common solution that can be used on multiple platforms and ultimately Operations & Maintenance (O&M) costs during the sustainment phase for these platforms (Logistics, Maintenance, and Training).

Radome inner dimensions:
Diameter: 5.875 inches
Length: 23.49 inches

Radome exterior dimensions:
Diameter: 6.88 inches
Length: 26.95 inches

Maximum Weight (including radome): 35lbs

Performance:
Elevation Coverage Pattern: +18 degrees to +45 degrees above the horizon
Radiation Pattern: Omni-directional in azimuth
Polarization: Right Hand Circular Polarized (RHCP)
Frequency Range: Ultra High Frequency Follow-On (UFO) uplink/downlink frequencies
Impedance: 50 ohms
Power Handling: 100W

The antenna will be characterized in a radio frequency (RF) measurement facility (Anechoic Chamber) or other suitable facility.

PHASE I: The company will develop a conceptual design of the Low Elevation Angle UHF SATCOM antenna that meets the technical requirements outlined in the description section above. The company will demonstrate the initial feasibility of this effort through software modeling and simulation. The Phase I Option if exercised, will include the

initial design and capabilities description to build a prototype in Phase II.

PHASE II: Based on the results of Phase I effort and the Phase II Statement of Work (SOW), the company will develop a prototype antenna for evaluation and test it on an SDV or other available platform. Coordination to use a Government test platform will occur through NAVSEA PMS340. This effort will focus on integration into a government-supplied radome (if desired) or other efforts to make the antenna suitable for use in a submerged marine environment. The prototype antenna will be characterized in an anechoic chamber or other suitable antenna measurement facility prior to integration and testing on an SDV or other available platform in an operationally relevant environment. Success during testing will be characterized by making successful UHF SATCOM communications with a UFO satellite at an elevation between 18 and 45 degrees above the horizon. Evaluation results will be used to refine the prototype into a final design that will meet the desired performance goals. The Government will be required to coordinate the use of Department of Defense (DoD) communications assets and to identify funding for Government test platform and support.

PHASE III DUAL USE APPLICATIONS: The company will be expected to support the Navy in transitioning the Low Elevation Angle Antenna for use on undersea mobility platforms. The company will support the Navy for test, validation and certification in accordance with SDV and DCS specifications to certify and qualify the system for Navy use and for transition to operational undersea mobility platforms. Following testing and validation, the end design is expected to produce a product that provides improved low elevation angle UHF SATCOM coverage. The technology is expected to be integrated into the Dry Combat Submersible and SDV Programs. Private Sector Commercial Potential: This technology could be used in any situation where there is a need to reliably establish communications with low elevation angle satellites where antenna size is limited. While this particular effort is tailored to marine environments this could be used for land, aviation, and space applications as well.

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KEYWORDS: Naval Special Warfare communications; SEAL Delivery Vehicle; UHF SATCOM Antenna; Satellite Communications; UFO Satellite; Low Elevation Angle UHF Mast Antenna

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Questions may also be submitted through DoD SBIR/STTR SITIS website.

N162-112 TITLE: Innovative Methods for Limited Dynamic Range Optical Detectors to More Effectively Operate in High Dynamic Range Environments

TECHNOLOGY AREA(S): Battlespace, Electronics, Sensors

ACQUISITION PROGRAM: PMS 495, Mine Warfare Office, Airborne Laser Mine Detection System (ALMDS)

OBJECTIVE: Develop an innovative technique to allow current state-of-the-art electro-optic systems to extend their dynamic range beyond their fixed capability.

DESCRIPTION: Organic mine countermeasures (MCM) give naval and marine units the ability to detect, characterize, and neutralize mines using their own assets. The US Navy and Marines fill gaps in MCM capabilities with electro-optic sensor systems. Airborne and underwater MCM sensors are vital to enabling operational maneuverability from the ship to the objective. To meet Naval MCM requirements, a "system-of-systems" approach has been adopted which consists of mine-hunting, minesweeping, and mine neutralization systems. These weapon systems are primarily deployed and operated from MH-60S helicopter platforms equipped with Airborne Mine Countermeasures (AMCM).

Mine-hunting is the preferred method of locating and neutralizing sea mines. One such system, which helps to fill a significant capability gap in complete coverage of the upper water volume and complements other MCM systems, is the Navy's Airborne Laser Mine Detection System (ALMDS).

The ALMDS provides a capability for the rapid detection, laser image classification, and localization of near surface moored mine threats. Moreover, ALMDS uses pulsed laser light and streak tube receivers (Ref. 3) in a push broom mode for high coverage rate. The transmitted laser light passes through the atmosphere, ruffled air-water interface, and seawater then returns along the similar path to the airborne receivers. This imposes an environmentally induced high dynamic range requirement over the area of interest, which is beyond that of the receiver, limiting system performance.

As with all airborne laser interrogation systems flying over water, the optical return from the surface of the air-water interface is relatively large and the return from within the water column decreases exponentially with depth as the optical scattering blurs the image (Ref. 1). The obvious objective is to clearly image from the surface to as deep as possible. Intuitively, increasing the dynamic range of the optical receiver would be the most logical approach; however, receiver technology limits the dynamic range. Setting the receiver gain too high saturates the surface return and setting the gain lower limits depth penetration. Note that laser safety and natural in-water phenomena limit the system's practical laser power.

The ALMDS program is currently experimenting with modifications to the pod receiver cameras to increase dynamic range (i.e. dual slope) and improve the quality of images at the surface (bright area) while maintaining depth performance. Additional concepts and techniques, which may be considered, are located within references #1-5.

This topic is seeking novel and innovative technological techniques and/or new software algorithms that will effectively increase the technology's dynamic range capability for its intended operational mission by extending the range (water depth) for target detection classification and location. Conceptual proposals should include discussions on any developmental history, technical risks, maturity levels, challenges, and applicable mitigation alternatives.

The intended product for Phase I is a technical report describing innovative technologies and novel techniques that will enhance the future naval system's limited dynamic range detector capabilities. These novel concepts must support operations in high dynamic range environments. Emphasis should be upon the technological feasibility to meet the Navy's needs that include but are not limited to an enhanced airborne active electro-optic system capable of detecting and identifying in-water objects, reduced false alarm rate, increased depth penetration, and sustained area coverage rate capability. The desired threshold improvement is an effective increase in dynamic range of 10% (for example, increasing a 10 bit dynamic range receiver to an effective 11 bit dynamic range).

This topic's intent is to provide significant increase in the ability to find mines in an expanded water column using innovative techniques utilizing current technology to modify MCM systems. Implementing these newly SBIR developed techniques with demonstrated feasibility of a capability increase into the ALMDS system is a cost

effective way to improve capability with a shortened developmental time for the acquisition program to support resulting in significant development costs. The ability to locate mines in depth regimes legacy systems have difficulty operating in has the real potential to save ship and life losses when hostile actions require ship presence.

PHASE I: The Phase I effort will articulate the feasibility of the concept to meet Navy needs and will establish if the concepts can be practicably developed into a useful product for the Navy as outlined in the description. The company will identify a methodology for integrating the high dynamic range environmental problem of active airborne Light Detection and Ranging (LIDAR) imaging through the air-water interface with current technology. Generating experimental data to predict performance, mathematical calculations, and modeling are in order to demonstrate proof of concept. The intended product for Phase I is a technical report describing innovative technologies and novel techniques that will enhance the future naval system's limited dynamic range detector capabilities. The Phase I Option, if awarded, should include the initial description and capabilities to build the unit in Phase II.

PHASE II: Based on the results of Phase I and the Phase II Statement of Work (SOW), the small business will develop a Phase II prototype for integrating the high dynamic range environmental problem of active airborne LIDAR imaging through the air-water interface with current technology. Metrics for increased performance for Phase II efforts will be defined to quantify the increased depth performance of an active airborne imaging system through the air-water interface based on the effective dynamic range increase. The company will provide the experimental test bed(s) (configuration of technologies and test equipment necessary to collect pertinent data) and/or prototype hardware/software configured for testing, evaluation, and data collection for the accompanying algorithm and model development. The company will demonstrate an increased performance (extending the sensor's native dynamic range) in terms of depth performance. The company will perform detailed analysis to ensure materials are appropriate for Navy applications. The company will deliver a final report documenting all findings to include recommendations for transition to Phase III for Navy use, along with all hardware and software prototypes developed under this effort.

PHASE III DUAL USE APPLICATIONS: The small business will apply the knowledge gained in Phase II to build finalize the design of hardware/software prototypes. Moreover, the company will demonstrate and characterize the performance in an operationally relevant environment as defined by Navy requirements and support the Navy in transitioning the technology for Navy use. Private Sector Commercial Potential: The technology and techniques developed will have direct applicability to other Government and private airborne LIDAR ocean sensing systems as well as laser interrogations systems operating through the air.

REFERENCES:
1. Josset, et al, LIDAR equation for ocean surface and subsurface, Optics Express, Vol. 18, Issue 20, pp. 20862-20875 (2010), http://dx.doi.org/10.1364/OE.18.020862

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3. H. Yang, et. al., Signal-to-noise performance analysis of streak tube imaging lidar systems: Part 1: Cascaded model, Part 2: Theoretical analysis and discussion. Applied Optics, Vol. 51, No. 36, 20 December 2012.

4. Arnaud Darmont, High Dynamic Range Imaging: Sensors and Architectures (First ed.). SPIE press, 2012. ISBN 978-0-81948-830-5.

5. Banterle, Francesco; Artusi, Alessandro; Debattista, Kurt; Chalmers, Alan (2011). Advanced High dynamic Range Imaging: theory and practice. AK Peters/CRC Press. ISBN 978-156881-719-4.

KEYWORDS: Airborne LIDAR (Light Detection and Ranging); imaging in high dynamic range environments; extending optical sensor's dynamic range; dynamic range compression; LIDAR signal processing; frequency modulated laser imaging

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Questions may also be submitted through DoD SBIR/STTR SITIS website.

N162-113 TITLE: Identify and Exploit Attributes of a Light Detection and Ranging (LIDAR) Signal to Improve Sea Mine Detection and Identification with a Low False Alarm Rate

TECHNOLOGY AREA(S): Battlespace, Electronics, Sensors

ACQUISITION PROGRAM: PMS 495, Mine Warfare Office, Airborne Laser Mine Detection System (ALMDS)

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 5.4.c.(8) of the solicitation. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Identify and exploit attributes of a LIDAR signal in hardware and/or software to demonstrate improved detection and identification of sea mine-like objects with a low false alarm rate for future Navy use.

DESCRIPTION: Organic mine countermeasures (MCM) gives naval and marine units the ability to detect, characterize, and neutralize mines using their own assets. The US Navy and Marines fill gaps in MCM capabilities with electro-optic sensor systems. Airborne and underwater MCM sensors are vital to enabling operational maneuverability from the ship to the objective. To meet Naval MCM requirements, a “system-of-systems” approach has been adopted which consists of minehunting, minesweeping, and mine neutralization systems. These weapon systems are primarily deployed and operated from MH-60S helicopter platforms equipped with Airborne Mine Countermeasures (AMCM).

Minehunting is the preferred method of locating and neutralizing sea mines. One such system, which helps to fill a significant capability gap in complete coverage of the upper water volume and complements other MCM systems, is the Navy’s Airborne Laser Mine Detection System (ALMDS).

The ALMDS is a helicopter-deployed system utilizing a streak tube imaging LIDAR system to rapidly detect, classify, and localize floating and near-surface moored sea mines. The ALMDS uses pulsed laser light and streak tube receivers in a push broom mode for high coverage rate. The transmitted laser light passes through the atmosphere, the ruffled air-water interface, through the seawater and returns along the similar path to the airborne receivers imposing an environmentally induced high “clutter” throughout the area of interest, which limits system performance (ref. 1). A variety of image processing techniques are utilized to optimize the probability of detection (Pd) and the probability of classification (Pc) as well as reduce the false alarm rate (FAR).

As with all airborne laser interrogation systems flying over water, the optical return from the surface of the air-water interface is relatively large and the return from within the water column decreases exponentially with depth. The ruffled sea surface redirects (scatters) the transmitted laser light, reducing penetration and scatters the light returned from any submerged object, blurring the image. The turbidity of the water column attenuates and further scatters the

transmitted light and blurs the return image (ref. 1). The electro-optic receivers (cameras) sometimes enhance the scatter glow and produce halos around bright spots and in high frame rate systems have image ghosts that further reduce image quality that hinders identifying a submerged object.

The Navy needs to be able to clearly detect and identify sea mines deployed from the surface to as deep as possible with ALMDS while sustaining a high area search rate and maintaining a low false alarm rate. The traditional methods for optimizing current airborne LIDAR system's capability of imaging through the air-water interface and through the water column is to create the best image possible and use a variety of image processing techniques to identify targets of interest within the return image (ref. 3). The current more mature LIDAR imaging systems use electro-optic techniques such as short laser pulses, polarization, specialized scanners, narrow field of view, range-gated receivers, and streak tube receivers to enhance the system's ability to provide better images for processing.

This topic is seeking novel and innovative techniques to exploit the laser signal for fusion with image processing techniques to: better detect, recognize, and identify mine-like targets; reduce the false alarm rate; and to quantify results. A variety of technologies and techniques may address this issue. These may include, but are not limited to: 3D imaging, narrow band laser filters, time delay integrate (TDI), polarization (ref. 2), coherent detection (ref. 3), speckle imaging, modulated laser beams (ref. 4), non-imaging techniques, and possibly other means of discriminating the ballistic photons returned to the receiver such as time discrimination (ref. 5). Conceptual proposals should include discussions on any developmental history, technical risks, maturity levels, challenges, and applicable mitigation alternatives. In addition, the proposal should state the expected performance improvement by the proposed method of exploiting aspects of the laser signal and clearly define how the proposer intends to demonstrate and measure the improved performance. (For a simple example: We will use our LIDAR imaging system and standard software as a base line of capability in a standardized laboratory target setup. We will then use technique 'xyz' by modifying the laser transceiver and the software accordingly and compare results.

The intended product for Phase I will be a technical report describing innovative technology concepts and novel techniques utilizing the laser signal of an airborne LIDAR system to enhance the future naval system's capability of detecting and identifying in-water objects and reduce the false alarm rate without sacrificing sustained area coverage rate. These novel concepts must support operations in the natural at-sea environment. Emphasis should be upon the technological feasibility to meet the Navy's needs that include, but are not limited to, an enhanced airborne active electro-optic system with increased capabilities of detecting and identifying in-water objects, reducing the false alarm rate and possibly increasing depth penetration without sacrificing sustained area coverage rate. The desired threshold improvement of a combined increased Pd/Pc and reduced FAR is 10%. This improvement, in consultation with the Government, may be demonstrated with most any mature system, a laboratory controlled experiment, possibly a mature model or some combination thereof. A clear description of the metric used to measure performance must be included.

This topic's intent is to provide significant increase in the ability to locate and identify mines as well as reduce false alarms using novel and innovative techniques exploiting attributes of the LIDAR signal to modify the ALMDS system. Implementing these SBIR developed and demonstrated techniques is a cost effective way to increase capability with a shorter development time. In operational mode, increased Pd/Pc and decreased FAR reduce secondary interrogation and mitigation, reducing time lines for mine countermeasures resulting in significant operational cost savings. The ability to increase Pd/Pc and/or lower FAR has the real potential to save ships and lives when hostile actions require ship presence.

PHASE I: The company will identify laser attributes for exploitation to better detect, recognize, and identify sea mine-like objects and reduce the false alarm rate while sustaining area coverage rate other than by image processing techniques alone. Determine the technical feasibility of the concept to meet Navy needs and establish if the concept can be practicably developed into a useful product for the Navy. Select experimental data to predict performance, mathematical calculations and/or modeling may be utilized to demonstrate proof of concept. The Phase I Option, if awarded, should include the initial layout and capabilities description to build the prototype in Phase II.

PHASE II: Based on the results of Phase I and Phase II Statement of Work (SOW), the small business will develop a prototype for evaluation. The Phase II SOW will cover the experimental test bed, which is the configuration of technologies and test equipment necessary to collect pertinent data, and prototype hardware and/or software for

testing, and data collection for evaluation and may be used for algorithm and model development. The small business, in consultation with the Government, will define metrics for increased performance (Pd/Pc and decreased FAR) and quantify system performance improvement. The company, in consultation with the Government, will demonstrate increased performance using developed prototype hardware and/or software. The company will perform detailed analysis to ensure any materials used are appropriate for Navy applications. The company will deliver a final report documenting all findings, detailed descriptions of any hardware or software developed under this effort and recommendations for transition to Navy use.

PHASE III DUAL USE APPLICATIONS: The company will apply the knowledge gained in Phase II to build an advanced test bed which will include a configuration of technologies including the developed hardware and software prototypes to demonstrate and characterize the performance in an operationally relevant environment as defined by Navy requirements. Based on demonstrated results, the intent is the insertion of these developments into the Airborne Laser Mine Detection System. If so, it is expected that the company would support the transition of the developed technology for Navy use. Private Sector Commercial Potential: The technology and techniques developed will have direct applicability to other Government and private airborne LIDAR ocean sensing systems as well as laser interrogation systems operating through the air.

REFERENCES:
1. Josset, et al, “Lidar equation for ocean surface and subsurface,” Optics Express, Vol. 18, Issue 20, pp. 20862-20875 (2010), http://dx.doi.org/10.1364/OE.18.020862.

2. Churnside, “Polarization effects on oceanographic LIDAR,” N21 January 2008 / Vol. 16, No. 2 / OPTICS EXPRESS 1196OAA Earth System Research Laboratory.

3. Christie Kvasnik, “Contrast enhancement of underwater images with coherent optical image processors,” 10 February 1996 @ Vol. 35, No. 5 @ APPLIED OPTICS.

4. Pellen, et al, “Radio frequency modulation on an optical carrier for target detection enhancement in seawater,” Journal of Physics D: Applied Physics, 34(7):1122, 2001.

5. S. Farsiu, J. Christofferson, B. Eriksson, P. Milanfar, B. Friedlander, A. Shakouri, R. Nowak, "Statistical detection and imaging of objects hidden in turbid media using ballistic photons," Applied Optics, vol. 46, no. 23, pp. 5805–5822, Aug. 2007.

KEYWORDS: Airborne LIDAR (Light Detection and Ranging) imaging through the air-water interface; mine detection; sea mine detection; LIDAR signal processing; frequency modulated laser imaging; Streak Tube Imaging; coherent imaging

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Questions may also be submitted through DoD SBIR/STTR SITIS website.

N162-114 TITLE: Modular Charge Delivery System (CDS) for Undersea Remotely Operated Vehicles (ROVs)

TECHNOLOGY AREA(S): Ground/Sea Vehicles

ACQUISITION PROGRAM: PMS 408, Expeditionary Missions

OBJECTIVE: Develop and demonstrate an explosive Charge Delivery System (CDS) for precision placement by means of an Undersea Remotely Operated Vehicle (ROV)

DESCRIPTION: U.S. Navy Explosive Ordnance Disposal (EOD) Forces are tasked with the remote neutralization of explosive hazards in the maritime environment. These hazards include naval mines and Improvised Explosive Devices (IEDs) placed in the water in order to damage ships or infrastructure. To counter Naval Mines and Underwater Improvised Explosive Devices (UWIEDs), US Navy EOD Divers are required to approach the device manually at severe risk to life in order to defeat the threat. Not only is this hazardous to the diver, the physiological limitations and decompression time add additional constraints such as staffing, chamber requirements, and decompression time. The dive profile for a decompression dive to greater than 200 feet can take more than two hours. The use of an Undersea Remotely Operated Vehicle (ROV) would allow smaller teams to work safely and quickly to restore access to mined ports, harbors and waterways. Lessons learned from fighting IEDs on land have shown the value in employing robotic systems when addressing explosive devices. These robots allow faster response times and reduce risk to life (Ref. 1).

There exists a need for an explosive charge delivery system that can integrate with a Commercial-Off-The-Shelf (COTS) ROV to counter naval mines and maritime IEDs that are floating, submerged in the water column (tethered or drifting), or positioned on the seafloor. This proposal is for the development of a “plug-and-play” kit that can be incorporated on to an existing COTS ROV or slightly Modified-Off-The-Shelf (MOTS) ROV. To meet EOD force needs the “plug-and-play” kit needs to interface with an ROV that is one or two person deployable/retrievable without the need for additional launch and recovery equipment. The intent is that the ROV will be operated from an F-470 or F-580 Combat Rubber Raiding Craft (CRRC). The CDS container should interface and function mechanically with the ROV (absent of a need for acoustic or electrical interface) in order to allow for adaptability and incorporation into future ROV chassis and end-effector developments (Ref. 2). In order to optimize effectiveness, the CDS container should be designed with consideration for ROV stability (metacenter, center of buoyancy, and other criteria) while minimizing cross sectional area to reduce drag on the ROV in strong currents (Ref. 3). The technical innovation required is to control the buoyancy and stability of the ROV throughout the operation.

There are alternative and costly weapon systems available or devices that utilize non-military firing systems. Currently, the Urgent Operational Needs (UONs) solution utilized by EOD forces expends a costly proprietary neutralizer to expend of a single naval mine. To avoid such costs, the proposed solution would make use of common demolition materials already in use by EOD forces. The proposed system will make use of standard military plastic explosives and firing devices in order to:

1) Streamline the Weapon System Certification processes. By using explosives and firing devices already approved for military use, the lengthy and costly process of certifying a weapon system will be reduced significantly.

2) Ease logistic burdens required with storing and shipping specialized weapon systems by utilizing existing explosives and firing devices already approved for storage on Navy installations and vessels.

3) Avoid life-cycle cost by providing EOD forces with a tool that incorporates common demolition materials already in service and stored in Explosive Magazines around the world. Not only does this ease the operational logistics of transporting the equipment, it leverages an existing infrastructure for storage, transportation, and training. This system will work with our standard C4 or equivalent and current firing devices. Those items are already in circulation and therefore do not require a logistic tail to support (storage, use, training, and production costs).

PHASE I: The company will define and develop a CDS concept for integrating with a COTS/MOTS ROV and placing charges on drifting, moored, and bottom mines. The company will demonstrate the feasibility of the concept through modeling and analysis to show that the concept will provide a cost-effective CDS that utilizes standard military demolition materials and allows for optimum ROV performance. The company will demonstrate in their

analysis the open architecture aspect of the design and how it would interface with multiple COTS/MOTS designs. Phase I Option if exercised, would include the initial layout and capabilities description to build the unit in Phase II.

PHASE II: Based on the results of Phase I effort and the Phase II Statement of Work (SOW), the company will develop CDS prototypes and provide support for evaluation. The prototypes will be evaluated in an operationally relevant environment against the performance goals defined in the Phase II SOW. This system will not be evaluated using live explosives. To understand the risk and scope of achieving required safety certification, the company will conduct a preliminary hazard analysis. The Navy will use this analysis to conduct a more detailed Operational Risk Management (ORM) assessment in support of Phase III. The company will deliver a final prototype at the end of Phase II.

PHASE III DUAL USE APPLICATIONS: The company will support the Navy in transitioning the CDS to operational use. The company will integrate the finalize design into the COTS/MOTS ROV, test and certify the complete system and provide recommendations for integration into the system into the Navy's MK 19 ROV Program of Record. Private Sector Commercial Potential: This technology provides capability for a small ROV to conduct precision placement of items on the sea floor. If desired, the containers could be fitted with various sensors (active or passive) for use in monitoring and/or recording activity in the undersea environment. This capability would have applications in Defense, Industry, and Research.

REFERENCES:
1. CDR (Ret) Reynolds, Thomas S., "How navies can adapt IED lessons for mine-countermeasures effort", Proceedings, July 2013; http://www.minecountermeasures.com/MediaCenter.aspx

2. Department of Defense, Unmanned Systems Integrated Roadmap (FY 2013-2038); http://www.defense.gov/pubs/DOD-USRM-2013.pdf

3. NOAA Ocean Service Education, "Tides and Currents", 25 March 15; http://oceanservice.noaa.gov/education/tutorial_currents/02tidal1.html

KEYWORDS: Explosive Ordnance Disposal (EOD) in a marine environment; Undersea Remotely Operated Vehicle (ROV); Improvised Explosive Device (IED) in a marine environment; Naval Mine Warfare; Mine Countermeasures; Undersea Robotics

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Questions may also be submitted through DoD SBIR/STTR SITIS website.

N162-115 TITLE: Advanced Persistent Cyber Threat Anomaly Detection

TECHNOLOGY AREA(S): Information Systems

ACQUISITION PROGRAM: PEO Integrated Warfare Systems (IWS) 1.0, AEGIS Integrated Combat System.

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of

sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 5.4.c.(8) of the solicitation. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a real-time capability for anomaly based detection of cyber-attacks in Internet Protocol (IP) based Combat System networks.

DESCRIPTION: Cyber-attack is a growing concern in military and commercial markets due to the increased sophistication and proliferation of hacker implements such as Denial of Service (DoS) tactics and zero day threats. Conventional approaches such as data encryption and virus definition files deployed through anti-virus software and associated updates are unable to address the increased complexity of today's cyber-attacks. Commercially available technologies for preventing attacks are not updating real-time to protect against emerging threats or assessing compounded system vulnerabilities, a Navy specific need for ensuring protection and operational availability of the combat and weapon systems integral to mission success. By developing a cyber-protection system architecture possessing the ability to detect an imminent cyber-attack on a real-time basis from one or more vectors, the Navy can protect vital data and communication equipment and software and prevent system failures due to cyber threats.

The Advanced Persistent Threat (APT) is a cyber-adversary that attempts to gain a stealthy foothold on a targeted system (Ref. 1). The APT can remain present (persist) within the targeted system for extended periods without being detected. An APT can potentially observe military tactics, techniques, and procedures for executing a mission. The APT can observe and corrupt the data used to plan and execute the mission posing a loss of life, risk to the war fighter, as well as mission failure. Being stealthy, the APT would have the opportunity to deny the execution of the mission at a time of the APT's choosing. The APT may accomplish this objective by depositing malware onto the target system via social engineering or supply chain infiltration. A layered defense in-depth strategy mitigates the APT, but additional capabilities to assess system health and behavior against the APT are desired so that if an APT is detected, the APT may be eliminated, isolated, or presented with disinformation to assure mission success.

The APT may target a system through any combination of three cyber-attack vectors: Data At Rest, meaning the files on the disk drives; Data in Execution, meaning data and computer programs in memory; and Data in Transit, meaning the data moving across a network.

State of the art techniques used to detect and mitigate the APT include file integrity checkers, anti-virus tools, automated computer log reviewers, network access controlled appliances, and rule-based System Information and Event Management (SIEM) tools. Heuristic algorithms are needed to compliment near real-time rule-based approaches to thwart the APT.

Current cyber techniques utilize code-signature mechanisms, such as virus definition files, which contain a set of digital signatures for previously identified malicious code, as well as real-time data encryption such as "https" protocol, Public Key Infrastructure (PKI) and NSA approved Triple Data Encryption Standard (Triple DES) to achieve cyber security. Such methods are more than adequate for communications with a validated network peer and supporting non real-time detection of the potential compromise of a suspect system utilizing file-scanning techniques. For low-bandwidth communications, rudimentary pseudo-real-time uses of code-signature techniques (such as email-scanning virus-detection processes) are used to help validate incoming data and prevent cyber-attack. The ability to detect a cyber-attack from one or more vectors, and pre-emptively secure the system from that pending attack (or immediately mitigate the effects of the attack if prevention is impossible), becomes a critical issue.

There is a need for a cyber-protection tool with the capability to detect imminent, un-documented cyber-attacks. The foundations of this system shall be derived from the development of pattern recognition sensors and algorithms developed by the proposer. The system will be capable of identifying and classifying cyber-attack methods based on data collected through network traffic, computer usage logs, and load monitoring software. Proposed cyber-protection architectures would need the capability to detect and identify cyber-attacks from multiple vectors

including network-based attacks, system infiltration attempts (zero-day and otherwise), and other malicious access and data infiltration techniques (Ref. 1). This will be accomplished in a manner that would allow continued system operation (Ref. 2) and for the deployment of appropriate attack-dependent cyber countermeasures designed to either eliminate the specific attack, or mitigate the effects of the specific attack, before extensive damage occurs. The software should not affect system message latency and have a low false alarm rate. Software testing to prove concept accuracy in pattern recognition will be done by the small business. Software certification will be a joint effort between the small business and the systems integrator.

PHASE I: During Phase I, the company will develop a concept for a real-time low or no latency anomaly detection capability for Combat Systems. The company will show the feasibility of this concept with a set of real-time pattern detection models, methods, and algorithms capable of identifying and classifying potential cyber-attack vectors and methods. These models, methods and algorithms would be based on real-time data collected through network traffic and load monitoring software, as well as real-time predictive algorithms enabling the potential classification of the attack within a period adequate to enable real-time attack mitigation and response. For example, a fast discovery scan to sequentially map a network for attack should be recognized within minutes while a shrewd adversary may wait hours between seemingly random connection attempts. Feasibility will be demonstrated by numerical, probability of detection analyses comparing sample baseline system and data attributes, and system and data attributes associated with experimental cyber-attacks. The Phase I Option, if awarded, will include the capabilities description to develop the software in Phase II.

PHASE II: Based on the results of Phase I and the Phase II Statement of Work (SOW), a prototype software with real-time capability will be delivered that could be integrated with any hardware and software systems. The prototype must be capable of demonstrating real-time attack pattern detection and attack classification prediction models in a timeframe commensurate with the requisite real-time attack response requirement. The company shall provide a detailed test plan to demonstrate the deliverable identifies the APT. A Phase III qualification and transition plan will be provided at the end of Phase II.

PHASE III DUAL USE APPLICATIONS: During Phase III, the company will support the Navy in the system integration and qualification testing for the software developed in Phase II. This will be accomplished through land-based and ship integration and test events. Private Sector Commercial Potential: Cyber-attacks on commercial companies have grown exponentially with ever-increasing sophistication in the types of attack. Public sector organizations deal with the ramifications of these attacks after the fact versus being able to respond to them in a real-time preventative manner. The technology developed under this effort would be directly applicable to the commercial need to respond to the same sorts of attack that the DoD is facing. Many DoD protocols and interface requirements are based on commercially accepted standards which facilitates a viable technology transition of this topic's technology to the commercial market.

REFERENCES:
1. Eric M. Hutchins, Michael J. Clopperty, Rohan M. Amin, Ph.D. "Intelligence-Driven Computer Network Defense Informed by Analysis of Adversary Campaigns and Intrusion Kill Chains" (PDF). Lockheed Martin Corporation Abstract. 13 March 2013. 4 June 2015. retrieved from http://www.lockheedmartin.com/content/dam/lockheed/data/corporate/documents/LM-White-Paper-Intel-Driven-Defense.pdf.

2. McDowell, Mindy. "Security Tip (ST04-015) Understanding Denial-of-Service Attacks" Department of Homeland Security United States Computer Emergency Readiness Team. 06 February 2013. 15 April 2015. https://www.us-cert.gov/ncas/tips/ST04-015

3. Department of Defense Instruction, No. 8500.2, "Information Assurance (IA) Implementation. 6 February 2003. http://www.cac.mil/docs/DoDD-8500.2.pdf

KEYWORDS: Detect and identify cyber-attacks from multiple vectors; detect a potentially imminent cyber-attack; cyber-protection architectures; network-based DoS; malicious access and data infiltration techniques; pattern

detection models

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Questions may also be submitted through DoD SBIR/STTR SITIS website.

N162-116 TITLE: Mobile Platform for the Fuels Asset Maintenance Management System (FAMMS)

TECHNOLOGY AREA(S): Information Systems, Materials/Processes

ACQUISITION PROGRAM: NAVSUP Fuels Asset Management and Maintenance System (FAMMS)

OBJECTIVE: Develop a mobile platform (hardware and software) that integrates with the IBM MAXIMO Enterprise Asset Management (EAM) system used by Fuels Asset Maintenance Management System (FAMMS)[1].

DESCRIPTION: FAMMS is utilized by Naval Supply Systems Command (NAVSUP) Fleet Logistics Centers (FLCs) to maintain petroleum, oils and lubricants (POL) facility equipment assets at Defense Fuel Support Points (DFSPs). The system tracks equipment assets and manages all aspects of fuel facility maintenance. Personnel currently rely on paper work-orders generated by FAMMS to update, distribute and post maintenance record data, a cumbersome and inefficient process. At the beginning of each month, NAVSUP FLC Fuel Department maintenance management personnel generate the month's work-orders and job plans. The job plans detail the steps to perform the work-order tasks and describe any safety precautions, hazards, special tools or materials and special instructions. The work-orders are printed, sorted, distributed and assigned accordingly. Upon completion of the assigned task, the maintenance personnel annotate pertinent information on the work-order (labor datum, hours, special comments, etc.) and hand in the paper work-order for manual entry into FAMMS. NAVSUP FLC Fuel Departments generate and print thousands of paper work-orders each month. In November 2015, nine of the 16 DFSPs using FAMMS generated and completed 7,561 work-orders. NAVSUP FLC San Diego averages 1,300 work-orders per month; NAVSUP FLC Puget Sound averages 800. Each work-order has multiple pages. One job plan for a scheduled annual work-order in NAVSUP FLC San Diego is 300 pages long. The period of time between the actual maintenance action (recorded on paper) and the data entry into FAMMS risks a loss of integrity due to latency. Data entry may also be slowed due to lack of completeness or legibility of the paper work-order. The labor used for data entry averages 435 hours per year at NAVSUP FLC Puget Sound (Manchester Fuels).

Developing a mobile platform for FAMMS will improve efficiencies in asset management and maintenance work-order processes. Implementation of this technology will enhance fuel facility labor management practices and improve productivity with continuous access to data. Time for data entry and record maintenance actions will be decreased since work data would be captured at the point of execution. Works order tasks assigned and distributed electronically eliminates the need to print reams of paper each month. The solution must provide a mobile platform that combines a hardware device and software applications that integrate with the IBM MAXIMO EAM system. The device must have a minimum of 4 gigabytes (GB) of Random Access Memory (RAM) to support the MAXIMO EAM system. The device screen size must be no smaller than 4 inches long by 2 inches wide. The device battery life must last throughout an 8-hour work shift without need for recharging. The device must be capable of both wired and wireless internet connectivity. The device's operating system must be capable of running when internet connectivity is not available (offline mode). The mobile device must comply with MIL-STD-810G, being ruggedized to withstand the work environment of a fuel facility or must be augmented by ruggedized accessories (protective cases, sleeves, screen covers). The software application must be able to synchronize data with FAMMS

that was entered into the mobile device while the device was in offline mode. It must run on any mobile device (Apple, Android, Blackberry, Windows). The solution (hardware and software) must meet the system DoD accreditation and certification requirements as cited in DoDI 8510.01, Risk Management Framework (RMF) for DoD Information Technology (IT), and DoDI 8500.01, Cybersecurity.

PHASE I: Develop the Mobile Platform for the FAMMS operational concept and select viable hardware and software solutions that meet the requirements identified in the description. The company will perform proof-of-concept and prepare any supporting documentation for technology development. The company will provide an initial layout of the capabilities and a plan for the development and demonstration of a prototype solution as part of Phase II.

PHASE II: Based on the results of Phase I, produce a mobile platform prototype solution, conduct a technology demonstration and deployment of the Mobile Platform for the FAMMS solution at an operational DFSP within the continental U.S.

PHASE III DUAL USE APPLICATIONS: Based on the results of Phase II, deploy the Mobile Platform for the FAMMS solution to all FAMMS participating DFSPs. The company will explore the potential to transfer the solution to other military and commercial systems. Private Sector Commercial Potential: Development of this solution to meet the Navy's POL asset management and work management maintenance needs would present the small business with the potential to apply the resulting technology to satisfy requirements for large commercial organizations in the fuel management and other sectors.

REFERENCES:
1. DoDI 8510.01, Risk Management Framework (RMF) for DoD Information Technology (IT), dated 12 March 2014.

2. DoDI 8500.01, Cybersecurity, dated 14 March 2014.

KEYWORDS: Mobile; Fuels; MAXIMO; FAMMS; Asset Management; Work Management, automated work order

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N162-117 TITLE: Materials Development for Affordable Maritime Compatible Radio Frequency Materials

TECHNOLOGY AREA(S): Materials/Processes

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 5.4.c.(8) of the solicitation. Offerors are advised foreign nationals proposed to perform

on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop novel low-cost techniques for high volume manufacturing of maritime Radio Frequency (RF) materials.

DESCRIPTION: There is a growing need for the development of high performance, low cost RF materials for the maritime environment. As the Navy begins planning for next generation platforms novel, affordable, maritime compatible materials will need to be developed. Current, conventional materials need to be improved to enhance their capabilities as a function of both bandwidth and performance. Current materials are also prone to degradation due to environmental effects, have weight issues and temperature limitations. Novel approaches to RF materials are desired that allow for maritime compatibility, wideband performance, broad temperature performance, and better mechanical properties. The specific materials of interest for this topic include materials with: high RF dielectric and magnetic properties, low and high RF electric and magnetic loss, and stiff and flexible materials. Techniques that achieve a number of these interests will be preferred. A manufacturing technique to develop these low cost RF materials is critical to the success of an affordable future Navy. Example applications include:

1) antenna size reduction materials (high dielectric and magnetic properties with low loss)– materials that have the potential to reduce the physical size of antennas while maintaining the RF performance of the antennas, specific emphasis should be placed on frequencies below 4GHz.
2) RF absorbing materials (high dielectric and magnetic properties with loss) – materials that show potential to far exceed the RF performance of current absorbing materials (carbonyl iron powder) in bandwidth, frequency of operation, weight, cost and environmental compatibility.
3) flexible materials (high dielectric and magnetic properties with and without loss) – maritime compatible materials that retain their mechanical properties over a very broad temperature range (-110 to +350 degrees Fahrenheit).

PHASE I: Demonstrate the ability to develop and manufacture an RF material with an index of refraction greater than 10 at 2 GHz. Characterize material(s) electromagnetic properties in-house or with ITAR controlled laboratories. Deliver to the Government a prototype sample of at least 1 sq. ft. in size and, if applicable, 100 grams of the filler material. Develop and present to the Government a plan to scale up the materials, either independently or with a materials manufacturing company.

PHASE II: Refine the manufacturing technique and demonstrate consistent electrical properties, temperature range and environmental stability by testing statistically meaningful material lots. Property requirements/goals will be refined in collaboration with the Government for specific applications. Once the requirements/goals are refined the contractor shall demonstrate scalability to tens of sq. ft. of material.

PHASE III DUAL USE APPLICATIONS: Finalize the development of material based solutions and work with an industry partner to develop processes so that the chosen materials can be readily implemented on existing and future Navy assets. In phase III, the technique will be applied to a large scale application. While the scope of the finalized affordable RF material manufacturing will be determined by the technique itself, the final state of the technology will be an adaptable low cost manufacturing process for high index of refraction RF materials. Private Sector Commercial Potential: Wireless technology is a large and growing part of the world economy. Affordable RF materials with high electric and magnetic properties decrease the size and potential weigh of the antenna systems.

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1. E. F. Knott, J. F. Shaeffer, M. T. Tuley, “Radar Cross Section”, Artech House, Inc, 1993.

2. Richards, Scheer, Holm, "Principles of Modern Radar: Basic Principles", Scitech Publishing, Inc., 2010.

KEYWORDS: Processing/Manufacturing, RF Absorbers, Flexible, RF Materials, Antennas

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Questions may also be submitted through DoD SBIR/STTR SITIS website.

N162-118 TITLE: Shipboard Radar Cross Section/Radio Frequency (RCS/RF) Verification of Airborne Platform

TECHNOLOGY AREA(S): Air Platform

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 5.4.c.(8) of the solicitation. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Design and develop a system capable of measuring the Radar Cross Section/Radio Frequency (RCS/RF) performance of Naval platforms or sub-systems (i.e. apertures) while deployed at sea.

DESCRIPTION: While assigned to the fleet, there is a need to quickly verify air vehicles' RCS/RF performance to maintain operational readiness. To find RF defects or changes, measurements are taken and then used to assess the health of the aircraft and antenna functionality. The operating costs and readiness levels of many current and next generation platforms are driven by their maintenance and sustainment need. Previous and current methodologies for precise platform measurements and antenna patterns have proven too costly to the point of being impractical. An onboard RF evaluation system suite that quickly and affordably takes qualitative measurements of the RCS/RF performance on an aircraft is ideal to check system ability. The baseline bandwidth for RCS/RF verification measurements will be 2-18 GHz with stretch objectives to go both lower and higher in frequency. This SBIR topic is intended to address three levels of RCS/RF verification over the noted bandwidth:

1) On-board verification – develop a handheld or similar device to perform near field RCS/RF verification on the flight deck or below deck in the hangar space.
2) Shipboard to air verification – develop a portable verification system that is based on board the ship and allows for the RCS/RF verification of aircraft as they fly near the ship.
3) Air to air verification – develop a verification system that is compact enough to be integrated into an air vehicle to perform air to air RCS/RF verification.

PHASE I: Determine the feasibility for the development of a RCS/RF verification measurement system. This will include a determination of what approaches might be possible to address the objectives listed in the Description section. As part of Phase I, the contractor shall demonstrate an understanding of the problem, the physics associated with the problem and provide a clear path towards build of a prototype and technology demonstration during Phase II.

PHASE II: Based on the Phase I effort, demonstrate and validate the RCS/RF verification measurement system. In this phase the small business shall build a RCS/RF frequency verification prototype system to measure an aircraft in at least one (and up to all) of the objective configurations. The bandwidth of the system shall be at least 2-18 GHz. Additional systems to go either lower or higher in frequency are encouraged.

PHASE III DUAL USE APPLICATIONS: Based on the Phase II effort, integrate the RCS/RF verification measurement system with a naval platform. Perform field testing to show the robustness of the system and to resolve issues with signature and RF measurements of aircraft in shipboard environments. Private Sector Commercial Potential: The RCS/RF verification measurement system can be used in the field to measure the RCS contributions from wind turbines. Also, the system has potential to measure and diagnose the RF health of antennas and "smart" vehicles.

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1. R. Cioni, A. Sarri, S. Sensani, G. de Mauro; "A Low-Cost Compact Measurement System for Diagnostic Imaging and RCS Estimation", Proceedings of AMTA 25th Meeting and Symposium, Irvine, CA, 2003.

2. Radar Cross Section Measurements and Simulations of a Model Airplane in the X-bandInácio Malmonge Martin, Mauro Alves, Guilherme G. Peixoto, and Mirabel Cerqueira de Rezende PIERS Online, Vol. 5, No. 4, 377-380, 2009 doi:10.2529/PIERS090220150258.
http://www.piers.org/piersonline/piers.php?volume=5&number=4&page=377

KEYWORDS: RCS, RF, verification, antennas, shipboard

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Questions may also be submitted through DoD SBIR/STTR SITIS website.

N162-119 TITLE: SiC-Based High Voltage Capacitor Charging Innovations

TECHNOLOGY AREA(S): Electronics, Ground/Sea Vehicles, Weapons

ACQUISITION PROGRAM: ONR 331 POM-15 Multi-Function Energy Storage FNC, ONR 35 Electromagnetic Railgun INP

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OBJECTIVE: Develop an advanced, modular and scalable capacitor charging converter that takes advantage of the unique characteristics of wide bandgap semiconductor devices. This converter will be capable of charging one or more 325kJ capacitor(s) to 6.5-10kVDC in 5 seconds at a repetition rate of up to 10 charges per minute. This duty cycle will be continuous without pause, and indefinite. The charger will be able to vary energy level and charge duration as needed to meet mission requirements, and present a manageable and reasonably continuous and level load to reduce effects on the power system.

DESCRIPTION: Future electric weapons, such as Electromagnetic Railguns, will require high-voltage supplies to provide power to their pulse-forming-networks (PFNs). While high-output-voltage power converters have been successfully applied in other applications, existing units have inadequate power densities to be deployed in

volumetrically constrained shipboard applications. Additionally, most existing high-output-voltage converters do not accept input voltages in the range of projected Navy power systems. In commercial and other military applications, wide-bandgap semiconductor materials such as silicon carbide and gallium nitride have enabled substantially smaller switching devices with greater thermal capabilities, higher breakdown voltages, and much faster switching frequencies. This technology can enable the development of more compact, better-performing, and more efficient high-voltage power converters.

The Navy capacitor charging application is very different from commercial capacitor chargers in that the power levels are higher (i.e. a greater amount of capacitance is being charged), the per-kW size is smaller to fit within the constrained space on ships, and the charging converters are operated continuously at high repetition rates. In addition, the Navy converters must be compatible with the shipboard environment with its unique shock, vibration, and other environmental requirements. For this reason, it is necessary to develop application-specific converters for this application rather than applying a commercial-off-the-shelf solution.

This topic pursues innovative means of charging capacitors from zero to 6.5-10 kVDC, in a rapid, repetitive manner, with a range of input voltages. The proposed charging converter to be produced shall have the following characteristics:
-Be able to draw power from a battery or rectifier source with input voltages of 650-1100 VDC. Different add-on front ends can be used to accommodate higher input electric distribution voltages of 6.5 kVDC, and/or 4160 VAC, with one of these selected for demonstration.
-Be able to charge 325kJ of capacitance (or integer multiples of this value to enhance power density) in 5 seconds and have a repetition rate of 10 charges per minute, continuously with no maximum number of charges.
-To minimize peak power demands on the source, the charging converter shall have a peak-to-average power ratio of no more than 1.1 over the charge cycle.
-Proposed concepts shall incorporate liquid cooling since they will ultimately reject their heat to water provided by the ship. Coolant will be 0-35°C Seawater and/or 5-40°Coolant (50/50 Propylene Glycol/Water)
-To fit within the shipboard environment, the charging converters should have a power density, using average not peak power, of 3 MW/m3 or greater, not including additional add-on modules proposed for interfacing with higher voltages. Dimensions will be tailored to best facilitate serviceability, changeout, and appropriate bussing within a group of charger units. The longest single dimension will not exceed 72".
-The outputs of the converters should be galvanically isolated from the input voltage.
-Parameters of the charging profile (i.e. the ramp rate of power at the beginning and end of the charge cycle) should be adjustable in order to be compatible with a variety of power sources. Load behavior will not include any large (>25%) drops or other behaviors that are unsupportable by prime movers or power system dynamic requirements.
-In order to be compatible with the shipboard environment, the final design should meet the following requirements: Shock MIL-S-901D, Vibration MIL-STD-167-1A, and Transportability MIL-STD-810G (design to but not test to these requirements under phase I/II).
-Suitable to be multiplexed to a single power converter or source. The controls for operation should allow multiple units to start charging simultaneously or with a variable delay.
-A desirable but not required attribute would allow the device to operate bidirectional, potentially enabling other uses in power conversion between 6.5-10kVDC and a lower feed voltage (650-1100 VDC).
-The small business may use any switching devices, power electronic topologies, and control strategies that meet the requirements above and herein as defined for the phases of execution.

PHASE I: Demonstrate the feasibility of an advanced, scalable, modular converter charger for 325 KJ capacitor(s) using wide bandgap switching devices. As applicable, demonstrate the effectiveness of the solution with hardware, modeling and simulation, and applicable engineering analysis. A Simulink simulation will be created under the base phase and delivered to the Navy. Hardware-based demonstration will support validation of the model, and a validated version will be provided to the Navy under the option phase, if awarded, as a Simulink file, capable of operating under the Opal-RT real-time HIL environment. Establish performance goals and provide a Phase II developmental approach and schedule that contains discrete milestones for product development.

PHASE II: Develop, demonstrate and fabricate a prototype with characteristics identified in Phase I. In a laboratory environment, demonstrate that the prototype meets the performance goals established in Phase I, as related to charging performance and continuous operations. Conduct performance, integration, and risk assessments. Update

simulations according to the as-built design attributes. Testing during this phase should demonstrate the ability to charge a capacitor(s) with the required charge time with rep rate capability. Thermal management will be sufficiently characterized to ensure that steady-state is reached. The unit, as built, will be assessed by simulation and implemented design practices for suitability to meet shock, vibration and environmental characteristics. The performer will then develop a cost benefit analysis and cost estimate for a naval shipboard unit. Provide a Phase III installation, testing, and validation plan, including shock, vibration and environmental requirements, which includes spare test units.

PHASE III DUAL USE APPLICATIONS: Working with the Navy and Industry, as applicable, design and construct a fully functional high voltage charging converter meeting all requirements listed in the Description section. The company will support the Navy for test and validation to certify and qualify the system for Navy use. The converter will be tested at full power and maximum rep rate during this phase in an in indicative manner at the vendor as a Factory Acceptance Test (FAT), and then at a Navy test facility where appropriate high voltage equipment can be demonstrated with it. The company shall explore the potential to transfer the technology during this SBIR effort to other military and commercial systems. Market research and analysis shall identify the most promising technology areas and the company shall develop manufacturing plans to facilitate a smooth transition to the Navy. Private Sector Commercial Potential: Technologies developed in this program are applicable utility and industrial applications requiring high density dc power conversion, especially those involving the charging of large banks of capacitors. Examples include fusion research facilities such as the National Ignition Facility (NIF) which use 100's of megajoules of stored energy. Technologies would also be applicable to more general medium voltage power electronics applications such as High-Voltage DC transmission (HVDC) systems, medium-voltage motor drives, and systems designed to interface alternative energy supplies to the medium voltage distribution grid.

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7. Shenai, K., "Wide bandgap (WBG) semiconductor power converters for DC microgrid applications," in 2015 IEEE First International Conference on DC Microgrids (ICDCM), vol., no., pp.263-268, 7-10 June 2015.

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9. MIL-STD-167-1A: http://everyspec.com/MIL-STD/MIL-STD-0100-0299/MIL-STD-167-1A_22418/

10. MIL-STD-810G: http://everyspec.com/MIL-STD/MIL-STD-0800-0899/MIL-STD-810G_12306/

KEYWORDS: Electromagnetic; capacitors; pulsed-power; converter; power electronics; pulse-forming; wide bandgap; silicon carbide; railgun; gallium nitride

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Questions may also be submitted through DoD SBIR/STTR SITIS website.

N162-120 TITLE: Trace Multi-Analyte Chemical Detection System for Underwater Unexploded Ordnance (UXO) Applications

TECHNOLOGY AREA(S): Ground/Sea Vehicles, Sensors

ACQUISITION PROGRAM: Expeditionary UUV Neutralization System (EUNS) in PMS-408

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 5.4.c.(8) of the solicitation. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a trace chemical / explosive sensor system for underwater unexploded ordnance (UXO) applications that is effective for TNT and other nitro-based underwater UXO analytes of interest.

DESCRIPTION: Navy Explosive Ordnance Disposal (EOD) response teams encounter a variety of underwater explosive threats including limpet mines, naval mines, underwater improvised explosive devices (UW-IEDs) and other UXO. A trace chemical/explosive sensor system will provide improved classification and identification of suspect underwater targets in missions for which acoustic and/or visual imaging alone are not effective. The chemical sensor package desired from this project will be capable of being integrated into a man-portable remotely operated vehicle (ROV). The goal of this program is to expand the existing trace chemical detection capability to include TNT and other nitro-based underwater UXO analytes of interest, such as RDX, PETN and HMX, as well as home-made explosive (HME) compound such as ammonium nitrate, triacetone triperoxide (TATP), and hexamethylene triperoxide diamine (HMTD). The current state-of-the-art is a single analyte sensor for detection of TNT, which only partially addresses the Navy's requirement to detect the full range of explosive threats.

PHASE I: Define and develop a concept for a multi-analyte sensor system to detect explosive threat compounds of interest at operationally relevant concentrations in seawater. Perform modeling and simulation to predict effectiveness against TNT and other nitro-based underwater UXO analytes of interest, such as RDX, PETN and HMX, as well as home-made explosive (HME) compound such as ammonium nitrate, triacetone triperoxide (TATP), and hexamethylene triperoxide diamine (HMTD). The weight and volume of the sensor should not exceed 25 pounds and 250 cubic inches. The maximum power requirement should not exceed 2.5 watts. The sensor's response time should not exceed 2 minutes. The minimum detection limit threshold should be 500 parts per trillion.

PHASE II: Produce a prototype sensor system based on the Phase I work. The prototype will be used to demonstrate and validate the concept developed in Phase I in an operationally relevant environment.
The weight and volume of the prototype sensor should not exceed 25 pounds and 250 cubic inches. The maximum power requirement should not exceed 2.5 watts. The probability of detection threshold value is .80 and the objective value is .95. The probability of false alarm threshold value is less than .15 and the objective value is .05. The sensor's response time should not exceed 2 minutes. The minimum detection limit threshold should be 500 parts per trillion. The sensor reliability should be greater than 80 percent and should operate from the ocean surface to a depth of at least 300 feet.

PHASE III DUAL USE APPLICATIONS: Integrate prototype sensor system into a man-portable ROV and demonstrate detection of underwater UXO chemical signature targets in an operationally relevant environment prior to transition to PMS-408. Private Sector Commercial Potential: Detection of underwater chemicals for pipeline inspection.

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KEYWORDS: Chemical sensor, explosive sensor, underwater sensor, remotely operated vehicle, underwater UXO, underwater IEDs

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Questions may also be submitted through DoD SBIR/STTR SITIS website.

N162-121 TITLE: New Condition Based Maintenance and Energy Command and Control Network Architectures for the Naval Expeditionary Force

TECHNOLOGY AREA(S): Ground/Sea Vehicles, Information Systems

ACQUISITION PROGRAM: Exchange of Tactical Information at the Tactical Edge (EAITE) FNT FY14-03

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 5.4.c.(8) of the solicitation. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: The objective is to research, assess, and develop a new ground vehicle based network to enable future advances in condition-based maintenance (CBM) and energy command and control (EC2).

DESCRIPTION: Naval Expeditionary Forces--specifically the US Marines, Navy Expeditionary Combat Command, and Naval Special Warfare Command--work in demanding and austere environments requiring reliable systems. There is a desire to research and implement new CBM capabilities for these forces to enhance a platform's operational availability while decreasing total ownership cost. This will necessitate new affordable health and usage monitoring systems, accurate prediction of the current state of vehicle health, notification of required maintenance actions, and better facilitation of overall fleet maintenance through data-driven decision making. Currently the US Army has a pilot CBM+ program that logs time series data from the vehicle's data bus that communicates with existing component diagnostics in the engine, transmission, brakes, and electrical systems (e.g., engine oil temperature and pressure, fuel rate, injection control pressure, etc.). Existing diagnostics from the original equipment manufacturers rely on state parameters like temperature and pressure, which present potential warnings after component damage has already occurred. The current pilot program primarily relies on connecting a laptop computer to a vehicle's CBM data logger once every month; data is then uploaded to the CBM data warehouse for further use. Standalone implementation of CBM wireless mesh technologies have also been experimented to automatically communicate with external nodes; this system currently has very low data rates that meet current needs. The data rates of this mesh technology may not be sufficient for the future vision of a more robust implementation of CBM. To elicit earlier indications and warning of component wear and damage, other CBM health and usage monitoring sensors are envisioned, such as low cost vibrational, corrosion, or fatigue sensors. Additional sensors will increase onboard or off-board computational requirements and likely tax the exchange and collection of health and usage data. There is a desire to fully automate the CBM process in the future by removing the need to physically connect to a vehicle to collect pertinent data, while increasing data collection frequency. In a garrison environment, health and use data may be automatically collected or uploaded at a Motor Pool upon vehicle dispatch/return, during preventive checks and services, or prior to corrective maintenance services. In a tactical environment there are additional challenges with the disconnected, intermittent, limited bandwidth (DIL) environment; potential cyber safe requirements; and potential cross-domain (classified/unclassified) movement of unclassified maintenance data from a classified operational data network to unclassified data warehouses. Additionally, the vehicle dispatch methodology doesn't apply in combat, especially before forward operating bases are established; therefore, collecting vehicle health and usage data will be increasingly important. This network architecture and automation of CBM may also enable a commander and maintenance leaders to have a dashboard view of the health of his/her assets to guide mission execution and support operational and logistics decision-making. It is envisioned that this ‘commander’s dashboard’ also fulfills the need to support future energy command and control concepts. Currently commanders lack the visibility of the energy/fuel posture of their force, so they lack basic knowledge such as the current operational reach (range) of their force prior to resupply. This lack of information, which may be fulfilled with health and usage monitoring information transmitted over new data networks, may be a contributing reason that we observe up to 70% idling of tactical vehicles in combat and training.

Finally, new vehicle network architectures must consider the pros/cons of the potential integration of operational, intelligence, surveillance, reconnaissance, and logistics communication /data requirements at the tactical edge in austere naval expeditionary environments compared to separate standalone logistics network solutions.

PHASE I: Define and develop an initial concept and a network architecture for the autonomous communication of condition based maintenance (health and usage) and energy command and control information for naval vehicles and riverine craft. The network must consider the potential for the integration of operational data and logistics (including maintenance and energy status data) across tactical communication capabilities versus standalone ad hoc network capabilities dedicated to CBM data. This may include consideration of future CBM data needs; onboard versus off-board data conditioning and processing; estimation of data storage and throughput needs; exploration of various secure communication schemes; persistent messaging and dissemination control; data fusion; and responsiveness to disconnected, intermittent and limited bandwidth environments.

PHASE II: Refine the network architecture for the autonomous communication of condition based maintenance and energy command and control information. This may include network modeling of various concepts of employment to select optimal network elements and flow. Establish a prototype hardware-in-the loop implementation of this network architecture with key vehicle/platform and network components passing and using emulated or live data to demonstrate network efficacy. Experiment with various optimization concepts.

PHASE III DUAL USE APPLICATIONS: Refine as needed, the final architecture and system design based on the results of the hardware in the loop demonstrations and experiments. Implement the network on a government selected naval expeditionary platform (e.g., ground vehicle, construction equipment, or riverine craft) for operational testing to support technology transition and additional commercialization. Private Sector Commercial Potential: ONR held a workshop in October on condition based maintenance. Major original equipment manufacturers are advancing condition based maintenance employment for commercial fleets; however, these industrial partners have access to unsecure cellular wireless infrastructure to support these programs making DoD CBM needs unique. But there is strong potential that the advanced health and usage monitoring network concepts presented in this SBIR program will benefit the commercial implementation of CBM and can be adopted by industry. Concepts like the 'commander's dashboard' would also be equally amiable to a construction/mining foreman's or fleet manager's dashboard for productive, cost-effective operations.

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2. Exchange of Actionable Information at the Tactical Edge. http://www.onr.navy.mil/~/media/Files/Funding-Announcements/BAA/2013/13-017.ashx; accessed Dec 2015.

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KEYWORDS: CBM; HUMS; network; architecture; energy command and control; cross domain; vehicle health

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Questions may also be submitted through DoD SBIR/STTR SITIS website.

N162-122 TITLE: Many Octave, Ultra-Sensitive Low Frequency Receivers

TECHNOLOGY AREA(S): Battlespace, Electronics, Sensors

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 5.4.c.(8) of the solicitation. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: The objective is to demonstrate Ultra-Sensitive Low Frequency Receiver with a compact RF front end that delivers better than 26 bit dynamic range and 1 Hz frequency resolution for >3 simultaneous signals of interest anywhere across 100 Hz to 20 MHz. This front end should encompass from the analog RF antenna feed into a commercial of the shelf (COTS) standard digital processor using a standard digital interface.

DESCRIPTION: Communications over the visual horizon is critical to operational coordination. Low frequency signals are more able to propagate around the world without relay stations than those at high frequencies. Unfortunately, intentional signals must also compete with high interference (effective noise floors) due to that ability and their usefulness for voice communications between, for example, taxi cabs and their dispatchers. Thus monitoring the weak signals in the spectra below roughly 20 MHz requires receivers with extremely large dynamic range. Historically analog channelization into a slowly scanning, narrow band receiver provides some awareness for platforms large enough to carry resonant antennas. Recently, magnetic field sensors and other approaches to electrically small, ultra-wide band antennas have been demonstrated, as have oversampling analog to digital convertors (ADC), which allow a fully digital, direct reception approach. That allows unrestricted parallelization of digital extraction of specific signals following cueing by a search mode. Beyond the complexity of the digital signal processor (DSP), the hardest technical problem is now to provide adequate inherent dynamic range and stability/accuracy of the required high clock rate analog to digital converters.

COTS acoustic ADC can achieve as much as 24 bit dynamic range for 5 or 25 KHz wide base band signals. However, to stare at 20 MHz of instantaneous band width(IBW) this way you need 800 channels or more, a nightmare for coherent clock & local oscillator distribution, component matching, and digital reconstruction of wider signals. Scanning lowers channel count but necessarily lowers either frequency resolution or probability of signal intercept. Direct, wide band digital reception is essential to full spectrum awareness.

The Phase I proposals must define an architecture for the entire front-end system. A technical risks section should be included with a discussion of the origin, nature and severity of each perceived risk, and potential solutions thereof, before clarifying which risk(s) would be reduced/retired during the phase 1 effort. Hypotheses should be offered as to performance one could expect at the end of phase 1 and 2. While smaller and lighter systems are always desirable, an entire front end system (antenna feed through to COTS Si processors) that occupies one 19 inch, full height rack or less and delivers user defined, arbitrarily chosen portions of the band is desirable.

PHASE I: During the Phase I effort, the front end architecture should be further developed and the highest technical risk component identified in the Phase I proposal be actively worked. The base phase should conclude with an Initial Phase II plan and refinements of the residual risks estimates. The option, if awarded, should further reduce technical risk.

PHASE II: The Phase II effort should develop and demonstrate a compact RF front end prototype that delivers better than 26 bit dynamic range and 1 Hz frequency resolution for >3 simultaneous signals of interest having different power levels and signal modulation types and IBW anywhere across 100 Hz to 20 MHz. This front end should encompass from the analog RF antenna feed into a COTS standard digital processor using a standard digital interface format, e.g. Vita 49. The base effort should focus on the part(s) (e.g. ADC) that initially prevents a

demonstration of over 26 bits difference in input power between pairs of large and small signals placed individually anywhere in the band. The first option, if awarded, should produce a demonstration of multiple signals similarly resolvable from a single data stream. The second option, if awarded, will most likely include a classified test of receiver readiness and functionality defined by the transition sponsor.

PHASE III DUAL USE APPLICATIONS: The Phase III will consist of any further required risk reduction and integration of this front-end prototype with the required back-end DSP subsystem of the transition partner's choice. Private Sector Commercial Potential: The primary commercial interest will be in the audio-phial market where extremely accurate recording of live music is required. They will, however, require a different power range and less instantaneous band width than DoD.

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KEYWORDS: analog to digital converters; direct reception; over-the-horizon communications; ducting; atmospheric scattering; thermal noise limits; oversampling

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Questions may also be submitted through DoD SBIR/STTR SITIS website.

N162-123 TITLE: Augmented Reality Technologies for Training: A Video-See-Through, Helmet Mounted Display

TECHNOLOGY AREA(S): Human Systems

ACQUISITION PROGRAM: CMP-FY17-02 - Future Integrated Training Environment (FITE)

OBJECTIVE: To develop a lightweight, small, low-cost, Helmet Mounted Display (HMD) to support Virtual Reality (VR) and Augmented Reality (AR) training applications for Marine dismounts.

DESCRIPTION: The commercial sector for HMD devices is growing: HTC Vive, Intevac I-Port, Oculus Rift, Samsung Gear VR, Sony Project Morpheus, and Star VR, etc. Variously these devices are expensive, bulky, clumsy, have low resolution, may be for video display only, and/or are designed for indoor/home use only. Most rely on a cell phone or a clumsy, bulky reflective interface. No single device meets and/or exceeds the objectives needed to perform in an outdoor setting - e.g, military training.

Recently, the Office of Naval Research transitioned the Augmented Immersive Team Training (AITT) capability. AITT enhances force-on-force (FOF) training of call-for-fire and close-air support. Currently, Marines cannot see simulated battlefield effects, such as munitions explosions, during FOF exercises. This training limitation is a

Marine Corps training requirements gap. AITT address this gap with Augmented Reality (AR) technology. AITT will transition the resulting science and technology products to the USMC FOF program of record and the Squad Immersive Training Environment (SITE) program – a "toolkit" of live, virtual, and constructive (LVC) technologies to enhance squad operational readiness and squad leader tactical decision-making skills. When the capability was transitioned it was noted that the current video-see-through technology was going to be discontinued and that there weren't any good available options for replacing the capabilities. This work seeks to develop an improved capability that can integrate within the Army and Marine Corps augmented reality efforts [1, 2].

The general device requirements are: a low-cost (<$1000) video-see through HMD that is rugged (e.g. outdoor use), have a small form-factor, be very low mass, have ultra-low electronic power performance, and capable of high-resolution HMD operation. The display must be unobtrusive and mountable on existing Marine Corps helmet Night Vision Goggle (NVG) rails. The device will additionally have three unique features: 1) the device will have dual forward facing "camera" sensors incorporated into its design. These sensors should be user-removable and user-replaceable, and operate as Electro-optical (EO) Infra-Red (IR) (EO/IR) low-light type devices; and 2) the HMD should contain miniaturized-high efficiency (low power) computational hardware and software together with; 3) an embedded inertial measurement unit (IMU) capable of precise, moment-to-moment spatial localization and attitude sensing of the wear's head anywhere within a 100 meter uncluttered area.

Specific device optical requirements include: 1) Field-of-view FOV approaching 120 degrees and 135 degrees, width/height, respectively; 2) a blended, high-resolution 60 pixel/degree FOV across the foveated display area; 3) a latency less than 5 ms; and 4) the HMD should have a refresh frame rate above 60 Hz. Trade-offs between the requirements are acceptable with priority for higher-resolution, less latency, and future upgrades.

Specific device IMU requirements include: 1) at least 6-Degree of Freedom (DOF) inertial measurement; 2) one or more secondary means of spatial localization (passive RF signals (commercial AM/FM radio), GPS, magnetic compass, astronomical recognition, or some other) would be a plus; and 3) the IMU must resolve with no less than 2000 degrees/sec baseline resolution in each rotational axis uncorrected by anticipatory filter algorithm. The IMU can be physically attached to the HMD although it is preferred the IMU be integrated into the HMD itself. The goal is to reduce the moment-arm and transient vibrations associated with distal mounting. Trade-offs between requirements listed here are acceptable with priority for smaller size and mass, lower-power, greater localization resolution and accuracy, and future upgrades among those that might be proposed by the small business. However, at minimum, we require improvements over a 1280X1024 pixel, full-color, 75° diagonal, with 60° H X 48° V display.

Specific device computational hardware and software requirements include a native capacity for the HMD circuitry to: 1) operate as software-defined, H.264 (V9) (level 5 or better, per page 307, Table A-7) video coding/decoding (CODEC) device [3]; 2) repeat-to-self its EO/IR sensor video, and 3) provide switch selectable transmission of its EO/IR sensor stream to an external device using Institute of Electrical and Electronics Engineers (IEEE) standard 802.3 (wired) [4] and (wireless) [5] embedded 802.11 RF transmission. Additionally, the HMD must be able to receive an externally sourced video stream (via 802.3 and 802.11) overlaying the stream onto (combining with) and or replacing its own video sensor stream completely. Trade-offs between requirements are acceptable with priority for smaller size and mass, lower-power, more flexible end-usage, and future upgrades.

PHASE I: Develop a concept for a low-cost, high-performance, HMD to superimpose computer-generated information on an individual's view of the real world. Demonstrate the feasibility of the selected concept (hardware/software system HMD device) to meet infantry Marine Corps needs through a set of specific Phase I deliverables.

Deliverables include: 1) An initial prototype or concept / mockup system; 2) A computer aided design (CAD) mechanical design package showing the top-level device and all major sub-assemblies anticipated; 3) Trade-off design decisions and associated justification for system design to include: recommended bill of materials (BOM), CAD, non-recurring engineering cost estimates (NRE), electronic hardware and software architectures, a recommendations list of display surface technologies, processor(s), and graphic processing unit(s).

PHASE II: Based on the results of Phase I deliverables evaluation the company will develop a working proof of concept HMD device for the Marine Corps. Prototype the HMD, conduct critical design review, and demonstrate initial capabilities are sufficient in existing Augmented Reality training applications. Deliver proof of concept devices (at least 2) for evaluation. The prototypes will be evaluated to determine their capability to meet Marine Corps needs and requirements for an augmented reality HMD. Deliver a final BOM, all CAD drawings, hardware schematics, software source code, and negotiated CMMI Level 2 Maturity [6] documentation.

PHASE III DUAL USE APPLICATIONS: The performer will be expected to support the Marine Corps in transitioning the HMD device. The performer will support the Marine Corps with integrating the HMD into service with existing Augmented Reality training devices. The performer will assist with certifying and qualifying the HMD system for Marine Corps use. The performer will assist in writing device Marine Corps user manual(s) and Marine Corps system specifications materials. As appropriate, the small business will focus on scaling up manufacturing capabilities and commercialization plans. Private Sector Commercial Potential: It is anticipated this technology will have broad applications in military as well as commercial settings. This effort could create a new product for the computer gaming, home and commercial entertainment, medical, machine operation, and many other markets. Similarly, a successful HMD may find application in search and rescue settings, law-enforcement tasks, water-craft piloting, some driving environments, and many other life uses.

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KEYWORDS: Augmented Reality (AR); Virtual Reality (VR); Heads-up-display (HUD), Helmet-mounted-display (HMD); Training; Games

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Questions may also be submitted through DoD SBIR/STTR SITIS website.

N162-124 TITLE: Software Tool for the Analysis of Optimal Training System Fidelity

TECHNOLOGY AREA(S): Biomedical, Human Systems, Information Systems

ACQUISITION PROGRAM: Live Virtual Constructive

OBJECTIVE: Develop a software tool to assess and validate the efficacy of simulation-based training technologies in an effort to enhance learning performance using "sensory analysis".

DESCRIPTION: This problem is critical for simulator and simulation design and development. Currently there are no systematic empirically based methods that provide meaningful direction to training developers to determine how much realism (e.g., fidelity requirements) is needed to train for mission effective performance. Fidelity related design decisions are motivated by the belief that the more accurately the simulation stimulates the human sensory system, the higher the probability that the system will provide effective training (Skinner et al., 2010).

The Navy needs a scientifically sound method for determining how much realism is needed to train a specific task. As budgets tighten, it is critical that these systems are optimized for training effectiveness. Other methods (e.g., user reactions) are more prevalent, especially using subject matter expert (SME) analysis. Another promising method of task analysis is sensory analysis that relies on a detailed analysis judging the capability of a system to produce required sensory cues. However, subjectivity of sensory analysis requires empirical validation. To maximize its effectiveness, it is necessary to understand: 1) how much fidelity is necessary for effective training, 2) the relationship between predictive and empirical training evaluation methods, and 3) if expertise level affects fidelity impact on training. However, additional methods and tools are needed to support these goals, resulting in optimal training for Warfighters, while yielding gains in time and cost reduction.

This effort should generate software that provides direction for training developers and human–computer interaction and ergonomics. The software tool and the associated guidelines, which would be a natural by-product of the software, should help developers to determine the level of fidelity optimal for effective training and interface design. The end result of this effort could generate clear and concise guidance that would enable subject matter experts to develop simulation-based training that is mission effective. To this end, this SBIR effort seeks an innovative software tool that can assess and validate the efficacy of simulation-based training technologies. This software tool, and any associated hardware required to run the software, will be used to evaluate current Navy simulator training and future simulation training design and development.

PHASE I: Determine feasibility for the development of an innovative software tool that can assess and validate the efficacy of simulation-based training technologies. During Phase I, the small business will 1) empirically define the concept of simulation fidelity which also incorporates cognitive and functional fidelity in operational terms, 2) based on this concept, the small business will then develop and define a plan for the full development of the software tool in Phase II, and 3) these prior two activities should then inform the development of objective and reliable methods to assess and validate the results of the sensory analysis. The end goal of this effort is to develop, during Phase II, the software tool and its associated guidelines, principles and algorithm(s) along with documenting the methods used to develop them. The small business shall provide a Phase II development plan with performance goals, key technology milestones, and a plan for testing and validation of the proposed fidelity guidelines/ algorithm(s). During the Phase I Option, if exercised, the small business must begin the processing and submission of any necessary human subjects use protocols.

PHASE II: Based upon the Phase I effort, the small business will develop the prototype software tool to assess and validate sensory analysis and training efficacy. During Phase II, the small business will also conduct a systematic, empirically based approach to validate the sensory analysis system as conceived in Phase I. A set of guidelines for training developers must be provided from these efforts explaining principles to be used in determining how much realism (e.g., fidelity requirements) is needed. This will require a demonstration to illustrate where training developers would apply the guidelines and principles to a wide range of task types to insure that the guidelines/principles can be generalized. This research and development effort must be conducted in the context of simulations/simulators that provide training of interest to Navy and/or Marine Corps (e.g., maintenance tasks). The results of the system demonstration will be used to refine the sensory analysis software tool prototype into an initial design that will meet DOD requirements. The small business will prepare a Phase III development plan to transition

the technology for Navy and/or Marine Corp use.

PHASE III DUAL USE APPLICATIONS: The small business will be expected to support the Navy in transitioning the sensory analysis software tool for its intend use. The small business will be expected to develop a plan to transition and commercialize the software and its associated guidelines and principles. Private Sector Commercial Potential: In addition to the military market, the technology could have broad applicability in technical training and education, consumer learner products, and developers of augmented and virtual reality systems.

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KEYWORDS: Fidelity, Simulation, Simulators, Sensory cues, Training Systems

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Questions may also be submitted through DoD SBIR/STTR SITIS website.

N162-125 TITLE: Read Out of Single Photon Cryogenic Array Detectors Via Energy Efficient Digital Means

TECHNOLOGY AREA(S): Battlespace, Electronics, Sensors

ACQUISITION PROGRAM: Future INP on IR sensors, following current ARC on Long range ISR in Degraded Visual Environments

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type

of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 5.4.c.(8) of the solicitation. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a capability to enable digital data reports from microwave kinetic inductance detector (MKID) arrays that are currently being read out via analog wideband frequency-division multiplexed (FDM) techniques.

DESCRIPTION: Imaging through dense fog is desirable from a continuity of operations point of view and is expected to be achievable using large arrays of highly sensitive, cryogenic photon detectors such as Microwave Kinetic Inductance Detectors (MKIDs). These detectors are typically cooled to very low (< 1 K) temperatures to obtain best sensitivity. Today's most prevalent readout method is to make each detector as a micro-resonator at a unique carrier frequency. Analog multiplexing in the frequency domain is then used twice: an analog signal comprising a closely-spaced frequency comb is sent down to the array by a programmable signal generator and the comb elements are amplitude and phase modulated by transmission through the resonator array. Allowing 1 MHz wide frequency domains per sensor, a 10,000-element detector array requires 10 GHz of instantaneous bandwidth.

Such a wideband, closely spaced frequency comb emanating from low-temperature is particularly vulnerable to nonlinear distortion and noise pick-up. It must be transported up the temperature gradient and to the signal analysis system with extreme fidelity in order to retain the information while also maximizing the field of view (FOV) of the imagery. Any nonlinearity in high-gain low-noise amplifiers that are required by current analog readout systems, can compromise the signal quality by creating intermodulation products. By performing digitization as close as possible to the sensing elements of the focal plane, signal quality will be maximally preserved. Therefore, while room temperature Analog to Digital Converters (ADC) are currently used in the read-out, digitization of the wideband signal on/close to the focal plane is preferable following little or no analog amplification.

Low-power cryogenic ADCs, such as superconductor ADCs, make this possible, even convenient, given the cryogenic requirements of the MKIDs. Digital readout approaches must balance requirements on instantaneous bandwidth (scaling in number of pixels in field of view) and dynamic range (impacting image contrast), which together determine the image quality, with total power consumption (<10 kW from wall desired). Digital multiplexing approaches of either electrical or optical character that reduce the number of output lines from the cryogenic environment are also of interest.
Superconductor ADCs with sample rates up to 100 GHz have been demonstrated. Such ADCs would need to be optimized for sensitivity, dynamic range, and low power consumption for the Frequency Division Multiplex Module (FDM) detector readout application while showing documented ability for co-fabrication with MKIDs. Semiconductor ADCs require demonstration of integration feasibility, including power dissipated in the cryogenic environment, and performance.

Phase I proposals need to define a definite approach to be taken and include an analysis of technical risks for this approach/application. The base period should noticeably reduce the total technical risk and produce the initial Phase II proposal. The Phase I option, if awarded, should further reduce the total technical risk. The proposed technical approaches should include all aspects of data transport, including cryogenic cables and data recovery circuits at room temperature. Approaches including standard non-proprietary interfaces are strongly preferred.

PHASE I: Develop a conceptual design through modeling and prototype circuit measurements for a complete digital readout system compatible with a large, scalable cryogenic detector arrays. Design should include quantified trade-off between ADC dynamic range and the number of pixels feasible to individually digitize. Quantify risk of non-linear distortion of array readout signal as a function of separation of frequencies in the comb.

PHASE II: Develop and demonstrate a prototype detector readout scheme and its associated components and integrate them on a cryogenic platform (consistent with that needed by MKID detector array) produced using a COTS cooler. By the end of phase II option demonstrate the operation of delivery and removal of a comb of 64 discontinuously amplitude modulated frequencies or more to a circuit with MKIDs-like output functionality. Experimentally quantify required separation of comb frequencies to achieve low bit error rate from digitizer to room temperature processors. In option II or before, replace MKIDS-like circuit with actual MKIDS linear array and

prove readout circuitry can report out all elements in at least a scanning mode. Determine the range of signal pulse durations reported. Engineer a readout system suitable for cost-share source's highest priority MKIDS system.

PHASE III DUAL USE APPLICATIONS: Build a first ever imaging system comprising a cryogenic MKIDS detector array and the readout circuit designed according to stakeholder's requirements and demonstrated to TRL4 or above in Phase II. Private Sector Commercial Potential: Both nuclear and high energy physics research requires large area, rad hard imaging arrays to allow accurate reproduction of complex events and discovery of new physics. The materials science, and conceivably manufacturing industry, also needs this sort of detectors for compositional uniformity metrics. Many petaflop computing centers may also benefit from this work if 4K superconducting circuits are used for the raw digital processing since many bit wide results data will need to be transmitted back to room temperature at high rates.

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KEYWORDS: Microwave Kinetic Inductance Detectors; imaging arrays; wavelength division multiplexing; frequency division multiplexing; cryogenic detectors; thermal engineering

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N162-126 TITLE: Human Interface and Automation for Swarm Management

TECHNOLOGY AREA(S): Air Platform, Ground/Sea Vehicles, Human Systems

ACQUISITION PROGRAM: Support of FNC/INP programs with distributed unmanned systems

OBJECTIVE: To develop and demonstrate a human interface and related decision support tools that allow human management of swarms of up to 100 unmanned vehicle systems in which communications are highly limited, attrition can occur, and individual swarm members may not have accurate state information about themselves and/or others.

DESCRIPTION: The last decade has seen substantial advances in the design of supervisory control interfaces that allow a single operator to manage multiple unmanned systems based on higher-level mission criteria such as objectives, constraints, priorities, allowable risks, and the level of autonomy for decision-making. Frequently, this is done through a combination of map, timeline, and vehicle status displays. However, existing multiple Unmanned Vehicle System supervisory control interfaces are typically designed under assumptions that may not be valid for

swarms. Swarming systems are here defined as systems which are scalable to large numbers of platforms and utilize decentralized control to enable robust collective behaviors despite only limited communications and state information. (e.g., for some types of methods, each vehicle would have the ability to intermittently keep track of or communicate with their nearest neighbors only). In contrast, assumptions for existing interfaces include: (1) relatively good communications with each entity or at least a good ability to project the future actions of each individual system, (2) a manageable number of discreet entities (e.g., individuals, cohesive groups that move in close formation, etc.), (3) well-defined methods to convey user intent and adjust as needed, and (4) a good user mental model of the automation. In comparison, a key reason to use swarming methods is that communications are limited, individual members may lack reliable state information about themselves and others, and swarm size and composition may change due to attrition. Swarming algorithms as well may demonstrate emergent behaviors (e.g., dynamic subgroup formation/dissolution) in which the group collectively completes a mission task in a way in which certain aspects of the overall group characteristics are predictable (e.g., boundaries, distribution over areas, etc.), but individual actions within the group are difficult to comprehend and predict. Finally, the types of control inputs that exist for different types of swarming concepts may bring new challenges to designing appropriate human interaction methods. Ways of controlling a swarm may include higher level mission criteria, more direct group control/influence, local control/influence of subgroups/individuals, and group or subgroup parameter adjustment to shape behaviors.

The goal of this effort is to develop and demonstrate a human interface and related decision support tools that enable users to more effectively understand, predict, shape, and redirect the behaviors/capabilities of highly decentralized systems to meet mission demands including a better understanding of (1) what are appropriate levels of user interaction with a swarm, (2) what metaphors are most effective for humans to use in managing these types of systems, (3) how should controls, displays, and decision support be designed to facilitate swarm management and tasking, and (4) what are the best times/modes for the operator to interact with the swarm and what kind of decision support/displays will best help the user infer or be guided to them. The focus of this effort is on humans interacting with swarms remotely via a computer interface of some type. The development of new platforms, network communications, or hardware of any kind is outside the scope of this topic. Existing capabilities for multi-modal inputs and new display concepts may be leveraged, but the focus is not on developing new multi-modal input systems like speech, sketch, or gesture or new display concepts such as 3-D audio/video or virtual/augmented reality. Concepts that require reliable, highly connected, and/or high-bandwidth communications with the swarm or near-perfect state information about the swarm are outside of the scope of this effort.

PHASE I: Develop a concept to demonstrate a human interface and related decision support tools of swarms of up to 100 unmanned vehicle systems. Perform initial limited structured human factors analysis to begin examining what is an appropriate level of interaction with swarms, and what are the best times/modes for the operator to interact with the swarm. A limited set of swarming methods may be used for this initial phase. A limited scope of platforms, environments, and mission tasks may be chosen for Phase I, but the chosen ones should also demonstrate the broader applicability of the concept. Mission tasks of interest include but are not limited to maritime or littoral environmental sensing/sampling, surveillance, search, tracking, and force protection. The system concept should support implementation within appropriate open architecture frameworks. It is preferred that the swarming algorithms used as a baseline be those found in the open literature. Based on this, develop a preliminary user interaction concept focusing on those new elements which appear most promising. This could be a static mockup or include some limited functionality by leveraging existing prerecorded data, limited-fidelity simulation elements and/or hardware elements as appropriate within the limited scope of the Phase I. Use this initial concept to perform a cognitive walkthrough at minimum. Develop experimentation plans and metrics to evaluate the system in Phase II and consider options for how the approach could integrate with a future swarming system.

PHASE II: Perform a more extensive structured human factors analysis of the domain to understand the specific warfighter interaction needs and constraints for swarm management, iterative development and evaluation of the human interface concept and related decision support tools with a broader range of swarming methods and mission tasks, and final development of a software prototype and evaluation of its ability to support swarm management. As much as possible, the Phase II design should be compatible with open architectures to be applicable to multiple naval operating environments. Phase II tasks should continue advancing our understanding of: What is an appropriate level of interaction with a swarm, what metaphors are most effective for humans to use in managing these types of systems, how can controls, displays, and decision support be designed to support swarm management,

and what are the best times/modes for the operator to interact with the swarm and how can the human infer or be guided to them. Final evaluation should include integration of the prototype with simulation and/or hardware elements with sufficient autonomy components to perform laboratory operator in-the-loop demonstrations and comparisons with benchmarks. Demonstrations with live assets may be used when of value, but are not required. Revise evaluation metrics and interface concepts as necessary. Ensuring that the demonstrations have representative complexity of the challenges of future swarm operations is of more importance than a very high degree of fidelity to an existing system.

PHASE III DUAL USE APPLICATIONS: Continue software development of the prototype as plug-in capabilities for relevant open architectures and address any unique requirements for interoperability with particular target domain(s), perform a more formal systems integration task to provide effective software interfaces to particular naval control stations and assets, perform component testing and operator evaluations, and participate in integrated demonstrations of autonomous system operations. Private Sector Commercial Potential: This capability could be used in a broad range of military and civilian security and first responder applications of unmanned systems and in other applications involving management of distributed automated systems, such as agriculture and scientific research.

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KEYWORDS: human interaction; swarming; unmanned systems; autonomy; unmanned air system; unmanned sea surface system; autonomous undersea system

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N162-127 TITLE: Shipboard Refrigerant Liquid-Vapor Phase Separator

TECHNOLOGY AREA(S): Ground/Sea Vehicles

ACQUISITION PROGRAM: Next Generation Electronics Cooling System FNC (proposed)

OBJECTIVE: Develop a compact and efficient refrigerant liquid-vapor phase separation system capable of operating under dynamic platform motion with minimal system impact.

DESCRIPTION: Two-phase cooling systems are being explored to extract large heat loads from future shipboard high-energy sensors and weapons due to their decreased size, weight, and power consumption. One such system, a two-phase pumped refrigerant loop, circulates refrigerant between the cold plate (evaporator) and the condenser, but the durability of the circulation pump and, thus, the reliability of the cooling system require that the refrigerant be a single-phase liquid at the pump inlet. Ensuring that no entrained vapor enters the pump can be accomplished by sub-cooling the refrigerant, but this adds system complexity, increases pumping power, and requires a larger condenser. Physically separating the vapor from the liquid is an attractive alternative, but traditional liquid-vapor separators can't be used in shipboard applications because they rely on the buoyant vapor rising out of a static pool of refrigerant. Recently, a number of phase separators have been developed for microgravity environments. However, the dynamic motion of a sea vessel will affect the two-phase flow regimes within the separator differently than microgravity. In addition, these separators have been designed to output a single-phase vapor for use in vapor compression cooling systems, instead of the single-phase liquid required for pumped refrigerant loops.

The goal of this topic is to design and fabricate a liquid-vapor phase separator for a refrigerant that delivers single-phase liquid under dynamic platform motion. The separator must comply with DOD-STD-1399/301a, which defines the criteria for the magnitude, period, and acceleration of various platform motions, e.g. the static design limit for ship roll is 45° from horizontal, and accept vapor qualities as high as 0.8, a refrigerant mass flow of several kilograms per second, and a saturation temperature near ambient. Separators should minimize their electrical consumption and pressure drop, as these impact the overall performance of the cooling system.

PHASE I: Develop concepts for compact, high efficiency liquid-vapor phase separator. Validate design performance through analytical modeling and subscale demonstration with vapor qualities up to 0.50 and orientation independence of +/- 30°.

PHASE II: Based on Phase I effort, build and demonstrate a prototype for the operation of a liquid-vapor phase separator capable of delivering 1 kg/s of R134a in a pumped refrigerant loop with inlet vapor qualities up to 0.8. The separator should maintain proper operation when subjected to the ship motion dynamics discussed in DOD-STD-1399/301a.

PHASE III DUAL USE APPLICATIONS: Finalize design and manufacturing plans for a liquid-vapor phase separator using the knowledge gained during Phases I and II. The separator is intended to be installed as part of a

two-phase pumped refrigerant loop thermal management system aboard a future surface combatant. Private Sector Commercial Potential: The development of refrigerant phase separators capable of operating under the orientation and dynamic motion associated with shipboard installation has commercial applications that include cooling of electric vehicles and commercial vessels.

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KEYWORDS: Electronics Cooling; Two-Phase Cooling System; Pumped Refrigerant; Liquid-Vapor Phase Separator; Thermal Management

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N162-128 TITLE: Computational Tools to Enable Development of Alloys and Coatings for Advanced Gas Turbine Engines

TECHNOLOGY AREA(S): Battlespace, Ground/Sea Vehicles, Materials/Processes

ACQUISITION PROGRAM: FNC EPE FY15-02 Gas Turbine Developments for Reduced Total Ownership Cost, Improved Ship Impact

OBJECTIVE: To develop a suite of computational tools that will accelerate the creation and development of alloys and coatings for gas turbine engines. The computational, informatics-based suite should be capable of utilizing various material database formats, and be able to convert and integrate modeling and simulation tools with experimental data and existing materials databases to provide the foundation for optimal materials design and development.

DESCRIPTION: Current state of the art software tools and associated infrastructure presently available do not address the data heterogeneity and fragmentation challenges in a way conducive to the feasible development and maintenance of high-quality databases of commercial alloys or coating reaching 12-15 components. This gap comprises a significant scientific and economic opportunity to enhance the ability of scientists and engineers to solve challenges in developing new engineering alloys and coatings. The quality of materials databases is uneven in the literature and requires labor and time to investigate and determine what constitutes viable materials data sources. As an example, the data required as inputs to Calculation of Phase Diagrams (CALPHAD) models are highly fragmented across numerous literature and non-literature sources. There is an urgent need for creating and developing specialized informatic tools for data capture, management, analysis, and dissemination. Advances in computer power created in recent years, coupled with computer modeling and simulation, and materials properties

databases will enable accelerated creation and development of new materials. Using these informatic tools as sources will facilitate Integrated Computational Materials (Science and Engineering) (ICMSE/ICME)) to reliably predict the composition and behavior of new materials. This proposed SBIR effort seeks the development of tools that will allow usage of various open and closed materials data sources to create useful thermodynamic and kinetic data formats with computational methodologies for creating and developing propulsion materials.

PHASE I: Identify a material (alloy or coating), material system, or material process that will produce a viable component for a marine gas turbine engine. Identify the boundary conditions to which the material, material system, or materials process must conform such as chemical composition, corrosion and/or oxidation resistance, fatigue, interdiffusion resistance, creep, resistance to phase transitions, coefficient of thermal expansion compatibility durability, stress, temperature stability, etc. The small business needs to assemble and assess a suite of modeling tools to predict processing outcomes and desirable materials properties. The modeling tools should have a history that the modeling results represent real-world conditions and provide an accurate mathematical representation of the engineering principles and relationships and predict the materials behavior that they were designed to represent. The small business needs to create an informatics-based framework that will be able to assess the type and quality of the databases required by ICME and other computational programs that can also work with materials modeling and simulation tools. The small business needs to demonstrate the functionality of this framework on a limited scale.

PHASE II: Using the outline of a framework created in Phase I, the informatics –based program needs to be expanded to determine the quality of different database sources. The program(s) should be able to identify errors in databases such as data entry errors, measurements errors, distillation errors, and data integration errors. Models should be developed to summarize general trends and complexity in data using e.g. linear regression, logistic regression focus on attribute relationships, identify data points that do not conform to well-fitting models as potential outliers, perform goodness of fit tests (DQ for analysis/mining), and check suitableness of model to data, verify validity of assumptions, and determine if the database is rich enough to provide the necessary inputs to the materials computational models. The small business should have a "good" baseline database so that the discriminating program can detect potentially corrupt sections in the test data set of other databases. The discriminating database program should be able to perform nonparametric statistical tests for a rapid section-wise comparison of two or more massive data sets, and repair errors in databases. The program should provide a means for capturing, sharing, and transforming materials data into a structured format that is amenable to transformation to other formats for use by ICME and other computational programs and modeling and simulation methods. The data can be searched and retrieved via several means.

PHASE III DUAL USE APPLICATIONS: The small business should engage with a government, public, commercial, company, or professional technical society that retains materials databases. The small business should demonstrate the means for capturing, sharing, and transforming materials data into a structured format that is amenable to transformation to other formats and the range of sources of materials databases it can use as inputs to materials computational tools that are used to describe various materials properties. The results should be compared to a previously verified "good" materials database. The small business also needs to interface with a software company that promotes and delivers materials computational programs to explore and develop an integration pathway for the database discriminating program with their software. The outcome of this technology development program will be a commercial suite of informatics-derived tools that can will be able to reliably analyze and discriminate various sources of materials databases to optimize the capability of ICME, other computational techniques, and modeling and simulation tools to work together to accelerate materials design and development for DoD ever-increasing material demands. Private Sector Commercial Potential: ICME and other computational programs are oriented toward reducing the time and cost of developing a material, a coating, or a materials system or manufacturing process in order to support the development of advanced products. But the military and the commercial world need to develop new informatics-based tools that will reliably discriminate various materials and properties databases so that these computational tools do not lead to flawed materials design. These informatics tools will help mitigate the time and cost to assess database quality manually. The tools developed in the research will expand and automate the determination of database quality so that integrated computational materials science and engineering tools provide more consistent results for public (Military) and private commercial use.

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KEYWORDS: ICME, materials database, materials development, data processing, regression analysis, modeling, infomatics

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N162-129 TITLE: Electrochemical Modeling of Anodic Metal-Rich Primers

TECHNOLOGY AREA(S): Air Platform, Ground/Sea Vehicles, Materials/Processes

ACQUISITION PROGRAM: POM17 FNC - Advanced Topcoat Systems; NAVAIR 4.3.4 Air Vehicle Engineering Materials Division

OBJECTIVE: Develop innovative models and analysis tools that support the maturation of metal-rich coatings, including their interaction with metallic and non-metallic surfaces and prediction of performance in the laboratory and naval operating environment.

DESCRIPTION: Metal-rich primers using anodic materials, such as the newly-developed Al-rich systems, are showing a great deal of promise for replacement of legacy chromated primers in aircraft. However, development and optimization of these primer systems is inhibited by a lack of understanding of how the entire system behaves and protects coated aircraft components, and assemblies in which they are used. Furthermore, the technology to manufacture these primers is quite advanced with regards to particulate size, loading and a number of other parameters that can be manipulated. Consequently, given this capability to customize the manufacturing process of such metal filled primers, a model-based analysis/optimization tool is required that can provide guidance on how to adjust these numerous parameters in order to optimize coating system performance.

Accurate electrochemical modeling is needed that explicitly accounts for the chemistry and structure of these metal-filled primers. This would make it possible to predict the behavior of the primer in a primer/topcoat system as a function of resin system chemistry, solvents, additives, metal particle alloy, particle size and shape, surface chemistry, and loading. This detailed modeling of the paint system must then be able to be used for guiding the choice of primer/particulate parameters for manufacture and an upfront prediction of how painted components will behave in aircraft galvanic assemblies.

This modeling must incorporate both the initial condition of the substrate/primer system, and changes that occur

over time, including degradation of the polymer matrix in which the particles reside, corrosion and dissolution of the particles themselves, corrosion products, and voids and other changes created in the system by the dissolution of the particles. This modeling must include charge transfer through the resin system, electrochemical surface reactions at resin matrix/particle interfaces, electrochemical surface reactions at the substrate/resin interface (including interactions with the substrate conversion/passivation coating), and electrochemical reactions at the primer/electrolyte interface of a non-topcoated paint system, and at the primer/topcoat interface of a system with supplementary coatings like a topcoat. It must also be able to model interactions between the primer materials and damage such as porosity, scratches, and holidays.

PHASE I: The small business will develop and demonstrate a proof-of-principle model for the electrochemical interactions of a metal-rich primer that incorporates interactions between the metal particles, substrate, and electrolyte based on the measured electrochemical properties of the metal rich primer system, including its polarization behavior and electrochemical impedance, using microscopic structure information and electrochemical measurements supplied by NAVAIR, augmented if necessary with additional test data.

PHASE II: Based on the results of the Phase I effort, the company will extend and fully develop a prototype software tool/model to include the explicit primer/substrate and primer/topcoat interactions, including modeling of scratches and other coating damage. The small business will incorporate this prototype paint-system model into an accurate electrochemical model of an assembly of components painted with Al-rich and Zn-rich primers, with and without topcoats, on aluminum and steel. The company will model how these primers will behave in the short and long-term in the presence of protection system damage and adjacent galvanically-coupled components of the assembly, such as stainless steels coupled to metal-rich painted aluminum. The company will apply this modeling to prediction of the behavior of assemblies such as the NAVAIR galvanic test assembly or actual representative aircraft assemblies.

PHASE III DUAL USE APPLICATIONS: The company will apply the knowledge gained in Phase II to optimize the model for certification which can be used by the Navy and commercial entities to accelerate the development, implementation and characterization of metal-rich primers and supporting materials like topcoats. The small business will support the Navy for test and validation to certify and qualify the model for Navy use. The company shall explore the potential to transfer the model to other military and commercial applications. Market research and analysis shall identify the most promising applications and the company shall develop validation plans to facilitate a smooth transition to the Navy, DOD and commercial M&P industry. Private Sector Commercial Potential: Metal-rich primers are used extensively in the commercial markets for the protection of transportation, storage, energy, facilities, and other structures. Advanced modeling capability will enable new and improved protective materials which are less costly to develop and faster to transition.

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KEYWORDS: metal-rich primer; protective materials; models; electrochemistry of coatings; degradation of coatings; lifetime prediction

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N162-130 TITLE: Advanced Energy Sources and Controls for Metal Additive Manufacturing

TECHNOLOGY AREA(S): Materials/Processes

ACQUISITION PROGRAM: EPE-FY-17-03 FNC entitled "Quality Metal Additive Manufacturing" or QUALITY MADE

OBJECTIVE: To develop a new energy source or improve an existing energy source or integrate multiple energy sources with their control units into a metal Additive Manufacturing system to better characterize and control key aspects of the metal AM process prior to, during and after processing of each layer.

DESCRIPTION: At the heart of any additive manufacturing (AM) process is the energy source that powers the thermodynamic forces that drive the metallurgical transformations that produce the microstructure that define the quality of the manufactured metallic parts. In order to make certifiable AM parts (i.e. defect and residual stress free parts with controlled microstructure and narrow tolerances) it is critical to control all aspects of the energy delivery system.

There are multiple parameters that control the microstructure of AM parts. Each particular AM process will have its own list of key control parameters. Some of these parameters include (without grouping them by process): the powder size distribution; powder layer thickness; wire feed velocity; energy beam spot size; melt pool temperature profile; the cooling rate; melt flow dynamic characteristics; evaporation rates and many others. As the process volume becomes smaller (to better control dimensional tolerances and microstructure) and as the process energy scanning speeds become faster (due to the faster heating and cooling rates associated with the smaller volumes) the requirements for higher precision, adaptability and agility of the energy source become more stringent. Most of the existing energy sources have some of these characteristics, but in order to further improve the quality of metal AM parts new or improved energy sources are required that have more of them.

Also, the AM process has inherent pre-, in-, and post-process variabilities associated with the powder size distribution, small processing volumes, high processing energies and fast scanning speeds that can affect the layer quality (such as surface roughness, microstructure distribution, residual stresses, alloy composition changes, defects). Accounting and correcting these variabilities is critical if we are to build quality metal AM parts. Since feedback control of the energy processing source is nearly impossible at the typical processing speeds found in most AM systems, it is highly desirable that as much information as possible is gathered of each layer before AM consolidation as well as after AM consolidation for purposes of feedforward control. Energy sources that can be used to characterize the AM material before processing and the consolidated layer after processing for purposes of feedforward control are desirable.

Finally, some of the desired attributes of the energy source and control unit could be, but are not limited to: dynamic control of the power level; energy excitation frequency; pulse duration and repetition rate, spot size control and energy distribution. Another desirable attribute of the energy source and control unit is the ability to switch to a low energy mode enabling in-situ measurement of various build parameters before, during and/or after the processing of each AM layer for building quality AM parts. Parameters such as: the powder layer quality and thickness prior to melting; monitoring certain aspects of the melting process (power level, melt pool temperature); and parameters after the melt processing could include measurement of the quality of the finished layer (surface profile, defect distribution) are critical for building quality AM parts via feedforward control.

For purposes of parameter estimation to assist with proposal preparation, the objective of this program is to develop an agile, adaptable and precise energy source and controller capable of AM'ing a quality part that weighs approximately 1 kg and occupies a volume of no more than 1 cubic foot in approximately 1 day.

PHASE I: During Phase I (concept formulation and development) the small business will determine, for the specific energy source that it chooses for this program, the key system parameters that need to be controlled and the ranges required to process common AM metallic feedstock material (such as Ti-6Al-4V, 316L SS, Inconel 625, Ni) to make quality AM parts. The small business will define and develop a protocol to characterize the AM material prior to processing, during processing and/or after processing each layer for purposes of feedforward control. This protocol should not add more than another day to the build process for a total of 2 days. During the Phase I the small business will validate key aspects of the concepts that were formulated to demonstrate feasibility.

Once all the key system parameters are determined and during the Phase I Option if awarded, the contractor will perform a preliminary design of the energy delivery and control system for making quality AM parts. Depending on the time and resources available during Phase I Option the contractor will start buying, testing and assembling the parts to build the system (energy source and controller). For the purpose of this program, a quality AM part is defined as one that is defect and residual stress free with controlled microstructure and narrow dimensional tolerances.

PHASE II: The Phase II effort should result in prototype development and validation of the system. The contractor will perform a detailed design of the system and will complete the purchase of all components and assemble the unit following the design established during Phase I. The contractor will write all the firmware and software code necessary to drive all the components of the system to produce the highest level of precision, adaptability and agility of the energy source in order to fabricate “quality AM parts”. The contractor will select a material system from the list provided above for the purpose of making simple geometrical test coupons to support the code development and system optimization tasks. For purposes of system performance validation, the contractor will fabricate a complicated metal AM part and will characterize its “quality”. It is highly recommended that the contractor work with a leading university professor in the field of metal AM and/or with an OEM that could help guide many of these tasks and ultimately provide an integration and transition path.

PHASE III DUAL USE APPLICATIONS: The "Advanced Energy Sources and Controls for Metal Additive Manufacturing" will be transitioned using funding provided by the Navy system program office interested in integrating the SBIR product into a complete AM system. The OEM involved during Phase II will be part of the transition team. Phase III will require integration of the Advanced Energy Sources and Controls with other AM process and controls (such as feedstock delivery system, build volume temperature control, gas handling system) required for a complete Metal Additive Manufacturing system. Private Sector Commercial Potential: Commercial applications include almost all commerce sectors such as: aerospace, shipping, transportation, rail, automobile, medical. Applications include almost all technology areas such as: engine parts, structural parts, mechanical or electrical parts, medical prosthetics, tooth implants. Finally material applications focus is on metals.

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KEYWORDS: Metal Additive Manufacturing, Energy Source, Material Processing, Microstructure, Defects, Residual Stress,

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N162-131 TITLE: Platform for Developing Collective Expertise

TECHNOLOGY AREA(S): Human Systems, Information Systems

ACQUISITION PROGRAM: The Distributed Common Ground System-Navy (DCGS-N) Program

OBJECTIVE: Develop computational models and tools for rapid training and development of collective expertise.

DESCRIPTION: The development of individual expertise depends on a) efficient teaching, b) the quality of the learning material, and c) objective assessment methods. Traditionally, teaching has been based on one directional interaction between a teacher and a student where the material is presented in "one-size-fits-all" fashion. Assessment of student's expertise has been conducted using a similarly crude approach by administering predesigned tests. Recent advances in technology provide the opportunity to revolutionize teaching and training by tailoring instruction to the needs and characteristics of each student [1,2]. However, the advances in the area of the assessment have been much more modest. The use of tests as the main tool for assessing student's mastery of the learned material is still difficult to replace with more efficient, but hard to implement, peer-based assessments [3].

While individual expertise is of great value for addressing a variety of tasks [4], it can be inadequate for addressing very complex tasks for which joint efforts of a group of trained individuals are required. Therefore, of particular interest is the development of a platform for training a group of individuals so they can achieve performance that cannot be matched by any group of individual experts operating independently. Unfortunately, the theory of expertise as it is currently defined has little to say about collective capabilities in terms of training and assessment of a group and therefore the associated theories and experiments are missing [5,6]. While adaptive learning methods have been developed for individual learners [7], new approaches are needed to automatically optimize the whole learning ecosystem by considering not just the parameters of an individual but also parameters of target content, peer interaction, as well as the instructor within group performance. Special focus should be devoted to rapid convergence, and efficient exploration of all ecosystem parameters.

It is clear that in order to develop group expertise, it is not necessary that each individual in a group achieve maximal possible (individual) expertise. Rather, of greater importance is how to develop complementary expertise, and how to develop mechanisms for efficient communication and collaboration [8] among group members. While the potential for large-scale collaboration has been demonstrated in certain domains [9], further efforts are required to generalize these findings to other domains where expertise is required.

PHASE I: Design experiments, and approaches that will be used for developing and testing collective expertise. Define approaches for conducting collaboration and efficient communication (e.g. discussion board or small group collaborations), matching members based on their expertise, and incentivizing collaboration. Identify and select learning tasks. Propose and discuss optimal design of group structure (e.g. centralized, hierarchical, flat, random, or cluster-based. Propose algorithms for peer-based assessment of learning and performance.

During the Phase I option, if exercised, design metrics for algorithm evaluation in Phase II including but not limited to issues related to: joint optimization of ecosystem parameters, rapid convergence, and efficient exploration of all ecosystem parameters; assessment of learning and assessment of group performance. Develop algorithms for peer-

based assessment of learning and performance.

PHASE II: Based on the effort performed in Phase I, conduct experiments and demonstrate the operation of the developed algorithm(s). Perform detailed testing and evaluation of the algorithm(s). Establish performance parameters through experiments; determine the range of group sizes the algorithm(s) can support, and the optimal group size that should be used for development of rapid expertise. In addition, define rapid expertise in terms of necessary time to develop collective expertise, class of task types, levels of difficulty, and prior expertise level.

PHASE III DUAL USE APPLICATIONS: The functional algorithm(s) should be developed with performance parameters. Finalize the design from Phase II, perform relevant testing and transition the technology to appropriate Navy and commercial training and simulation efforts. Private Sector Commercial Potential: This technology will primarily support rapid learning and development of group expertise by developing methods for adaptive presentation of materials and efficient evaluation and testing strategies. Therefore, this technology can be easily transferred to all institutions that require learning, training and evaluation of its personnel. This includes educational institutions as well as businesses that depend on continuous training and re-training of its employees.

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KEYWORDS: Rapid training, adaptive learning, collective expertise, decision-making, assessment and evaluation.

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Questions may also be submitted through DoD SBIR/STTR SITIS website.

N162-132 TITLE: High Volume Packaging and Integration of MicroElectroMechanical Systems (MEMS) with Energetic Components

TECHNOLOGY AREA(S): Electronics, Materials/Processes, Weapons

ACQUISITION PROGRAM: FNC JS-EMW-FY17-01 High Reliability DPICM Replacement (HRDR)

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 5.4.c.(8) of the solicitation. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop and demonstrate packaging and assembly techniques that can be utilized for the integration of MicroElectroMechanical Systems (MEMS) with energetic materials and are scalable for high-volume production applications.

DESCRIPTION: MEMS are an emerging technology that are the focus of several efforts to develop miniature Safe and Arm (S&A) and sensor prototype devices for Navy and Marine Corps munitions. These efforts include the integration of MEMS components and energetic materials (explosives and propellants) to produce devices that can be directly integrated into munition fuzing systems. These devices must be packaged in a way that ensures the long-term survivability and reliability of the microscale mechanical and energetic components. The packaging techniques utilized must also be scalable and compatible with high-volume manufacturing techniques capable of affordably producing thousands to millions of devices in a parallel fashion.

The work proposed in this topic involves developing and demonstrating techniques that can be used to package micro energetic components (sub-millimeter to millimeter scale) that have been integrated with silicon-based MEMS devices. Work should focus on wafer to wafer alignment and bonding, post-bonding die singulation, and handling, alignment and assembly of explosive components (pellets) utilizing methods such as pick and place.

The packaging and assembly techniques developed must be compatible with explosive materials. Explosive compatibility includes limiting bonding temperatures to 150 ºC or less or applying localized heating techniques if temperatures that exceed 150 ºC are utilized. Minimizing environmental stimuli, such as electrostatic discharge (ESD), shock, and vibration during component handling is also critical. While various low temperature wafer bonding techniques have been developed in academia and industry, none have been reported to have been demonstrated with energetic components. The developed techniques should also be compatible with sensitive MEMS components such as low-stiffness spring-mass systems (accelerometers and g-switches) so that stiction and other mechanical damage is not induced during packaging.

PHASE I: Define and develop conceptual techniques for energetic component handling and placement, wafer alignment and bonding, and die singulation. Perform modeling and simulation to determine heat transfer to energetic components and stresses induced on MEMS components due to packaging. Feasibility/proof of concept shall be established during the Phase I base using modeling and simulation and/or other experimental techniques. During the Phase I Option, if exercised, design test structures and produce wafer layouts for devices that can be fabricated for complete concept feasibility and tested in Phase II.

PHASE II: Fabricate test wafers based on layouts produced in Phase I in quantities sufficient to demonstrate and validate the proposed component handling and packaging techniques. Determine the effectiveness of the proposed techniques by assembling prototype packages and subjecting the packages to testing that validates bond strength, integrity, and hermeticity and proper post-assembly MEMS component performance. Analyze test and evaluation

results and recommend go-forward assembly techniques that can be used to produce prototypes in higher volumes during a possible Phase III project continuation. Deliver limited test devices to the government for additional testing and inclusion in munition subsystems.

In the Phase II base, techniques can be initially demonstrated on an individual chip level or with partial wafers if it can be proven that they can be readily scaled to a wafer level with a high degree of confidence. Initial assembly trials can also be performed with inert simulants instead of energetic materials if it can be demonstrated the developed processes can be utilized with energetic materials with a high degree of confidence. During Phase II Options, if awarded, the developed techniques should be demonstrated on the wafer level with tactical energetic components.

PHASE III DUAL USE APPLICATIONS: Build upon packaging and assembly techniques developed and demonstrated throughout Phases I and II in order to demonstrate that packages can be reliably produced in high volumes. Deliver MEMS S&A packages that are suitable for integration into the JS-EMW-FY17-01 FNC program and a TBD follow-on acquisition program. Private Sector Commercial Potential: The developed techniques will be applicable to any MEMS devices that contain energetic materials, heat sensitive components, or otherwise contain delicate components that require low-temperature assembly techniques. Examples could include ignition safety devices (ISD) for commercial rocket motors or detonators for automobile air bags, mining, and demolition.

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KEYWORDS: MEMS; Wafer Bonding; Packaging; Energetics; Fuze; S&A; ISD; Hermetic

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Questions may also be submitted through DoD SBIR/STTR SITIS website.

N162-133 TITLE: Autonomous Mobile Marine Meteorological Station

TECHNOLOGY AREA(S): Battlespace, Ground/Sea Vehicles, Sensors

ACQUISITION PROGRAM: Proposed FNC on the EM effects in near surface conditions; also EM Railgun for over water targets

OBJECTIVE: The objective is to develop an autonomous, mobile, marine meteorological station with the capability to launch radiosonde balloons for marine boundary layer characterization. The challenges of this development are stability of the platform for measurements, real-time data transmission, gas-handling, and unmanned surface vessel (USV) autonomy.

DESCRIPTION: For air-sea interaction measurements, it is important to measure the atmospheric boundary layer at the same time that we measure the ocean wave boundary layer and the ocean mixed-layer parameters. Because we have moved field measurements in the ocean to autonomous vehicles, we now have a mis-match between the measurements of the ocean wave-boundary layer and ocean mixed layer and the atmospheric boundary layer. The radiosonde measurements of atmospheric parameters for the upper 10-1000 m, the near surface humidity, temperature, particle concentration, wind speed, direction and pressure, and other meteorological measurements have historically been made from ocean research vessels. We would like to create a matching autonomous sampling capability for the atmospheric boundary layer. This capability would provide tremendous cost-savings; a ship-day costs from $25K to $55K a day. We estimate that a fully-operational USV with meteorological measuring gear could cost about $500K; however, its mobility but would create an appropriate match or time and spatial sampling with autonomous ocean gear like gliders, floats, etc. The present methods of measuring boundary layer data and fluxes at sea are very rough and crude with a large loss of accuracy - this will improve the quality as well as quantity of the data.

The objective of this program is to develop a mobile, steerable meterological measurement system that is capable of measuring the atmospheric boundary layer from just above the wave tops to the stable atmosphere. The following parameters are desirable:
Real-time reporting
Steerable, stable platform with navigational accuracy to 1 meter over 1 hour
Duration of 2-6 months
Retrievable (desirable but not a hard and fast option)
Deployable from surface vessels
Operating conditions: operational up to Beaufort Scale 4 [winds 13 - 17 mph;
wave height 3.5 - 6 ft; small waves with breaking crests; fairly frequent whitecaps]
Functional at storm conditions is desirable but also needs to be examined as a trade-off

Supports the following measurements:
Pressure, temperature, humidity, wind speed, wind direction, aerosol concentration
Supports the release of radiosondes or equivalent measurements through the boundary layer to the stable atmosphere (this should be part of the trade-off study)

This leap-ahead technology would also have tremendous utility to other agencies that support at sea-operations such as the Coast Guard, NOAA, the Navy METOC community

PHASE I: Develop initial concept design and evaluate potential components that can meet the operating and environmental criteria outlined above. Perform trade-off studies of cost, compatibility and capability; utilize market surveys, modeling, and or simulations to demonstrate feasibility. Create the initial design and interface control document. Under the option, if awarded, detail the costs, components, and structure of a prototype.

PHASE II: Based on Phase I work, construct a prototype system and demonstrate:
(1) operational efficacy in a maritime environment across the range of environmental conditions outlined above, meeting minimum thresholds, (2) collect and relay in real-time data sets for evaluation, and (3) engage in a comparative study of data quality against fixed or boat-based systems. (4) describe and detail cost advantages for

productions of 10-50 units. Identify applications and benefits to the commercial and private sectors.

PHASE III DUAL USE APPLICATIONS: Conduct a full-scale scenario operational demonstration of the Phase II prototype. Integrate into the broader FNC programs or DRI programs to provide an operation use evaluation and to demonstrate viability across the naval force. Develop plans for scaling up manufacturing capabilities and commercialization plans with emphasis on price point and reduction for large numbers of units. Private Sector Commercial Potential: Industry, other governmental, and NGO organizations engaged in weather forecasting, climate-change assessment, marine condition forecasting, oil spill assessment and response, disaster response, disaster relief and recovery, maritime recovery, and marine science and exploration—conducted in countries/regions possessing or lacking developed maritime infrastructure—will benefit from this product.

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3. Naval Expeditionary Logistics: Enabling Operational Maneuver From the Sea; 1999; National Studies Board; http://www.dtic.mil/dtic/tr/fulltext/u2/a413072.pdf

KEYWORDS: autonomous surface vehicle; mobility; near-surface meterology; radiosonde measurements; humidity, atmospheric pressure; air temperature, atmospheric stability

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Questions may also be submitted through DoD SBIR/STTR SITIS website.

N162-134 TITLE: Composite/Meta-Materials for Multi-band Satellite Antenna Applications

TECHNOLOGY AREA(S): Electronics, Information Systems

ACQUISITION PROGRAM: Commercial Broadband Antenna Program, ACAT III

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 5.4.c.(8) of the solicitation. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a prototype radome and multi-band (at least C and Ka bands) antenna system that features an ideal mix of traditional metallic and composite materials as well as candidate advanced composites and meta-materials to allow placement on aircraft carrier mast or superstructures and protection/relocation from jet blast.

DESCRIPTION: Due to the large size (3.53 m diameter) and weight (818 kg) of C-band satellite antennas, the placement of these on aircraft carriers are limited to a very few locations excluding the mast on the superstructure.

Accordingly, these antennas must be placed at a low enough point to reduce the center of gravity on the structure. Currently, antenna placement results in a sub-optimal location that is subject to significant blockage from the superstructure. Current approach to overcome this problem is the employment of a dual antenna array (fore and aft) along with complex electronic switching systems, dual sets of waveguides, and specialized satellite modems. Additionally, a new problem has been introduced on board aircraft carriers with the recent introduction of the Vertical Take-Off and Landing (VTOL) aircrafts such as Harrier and F-35C Joint Strike Fighter. The jet blast resulting from take-off and landing of these VTOL aircrafts have resulted in the destruction of radomes as well as the antennas they protect from the environment. These radomes and antennas were anticipated to have a long service life; however, the sparse set of spares are being depleted at a rapid rate. This is an untenable situation that requires an alternate means to solve this problem.

Efforts to address this problem should be focused on the areas of:
(1) Identify or develop methods for using advanced composite and/or meta-materials to yield significantly lighter antennas, gimbal mechanisms, and pedestals with equal or greater performance,
(2) Identify or develop advanced composite and/or meta-materials that will result in the ability to yield multi-band reflector arrays (i.e. advanced composites and meta-materials that selectively responds to multiple simultaneous set of wideband and narrowband satellite signals), and
(3) Using the knowledge gained and materials identified/developed under areas (1) and (2) to reduce large satellite antenna count and to allow mounting the lighter multi-band antennas on the aircraft carrier's mast or upper superstructure so they are not subject to blockage or jet blast from VTOL aircraft.

PHASE I: Determine the symbiotic relationship between the reduction of antenna weight to the corollary reduction in size and weight of the gimbal mechanism and pedestal. Identify the optimal trade-off for the use of some combination of traditional metallic structures, composites, advanced composites, and meta-materials that yields maximum service life at the best cost point. Determine the feasibility of developing a multi-band antenna that can replace at least two discreet satellite antennas. Study the use of advanced composites and meta-materials that selectively responds to multiple simultaneous sets of wideband and narrowband satellite signals.

Determine alternate locations for the innovative new antenna on the aircraft carrier's mast or upper superstructure. Also determine the effects on the radome from VTOL jet blast on the candidate antenna placement location.

PHASE II: Develop a prototype radome and multi-band (at least C and Ka bands) antenna system that features an ideal mix of traditional metallic and composite materials as well as candidate advanced composites and meta-materials. Characterize the performance against current Force Level Variant (FLV) FLV Commercial Broadband Satellite Program Antenna system, AN/USC-69(V)2. Produce complete radome and antenna model with electronics assemblies represented by appropriately placed non-functioning mass that can be tested at China Lake's shock, vibration, and environmental stress test facility to Navy Multiband Terminal (NMT) specifications. Determine survivability of the new multi-band antenna system's ability to survive the potential VTOL jet blast at the revised antenna location.

PHASE III DUAL USE APPLICATIONS: Produce production representative prototype for testing on aircraft carriers, increase Technology Readiness Levels (TRL), and, potentially, perform limited fielding of the antenna systems. Private Sector Commercial Potential: Commercial satellite programs such as O3b Networks used on commercial cruise liners can benefit from the reduction of antenna arrays required on ship.

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http://www.public.navy.mil/spawar/Press/Documents/Publications/1.25.12_AFCEA_Kit_IX.pdf

KEYWORDS: JSF, gimbal, commercial SATCOM, MILSATCOM, multi-band antennas, meta-materials, advanced composites

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Questions may also be submitted through DoD SBIR/STTR SITIS website.

N162-135 TITLE: Shipboard Troposcatter

TECHNOLOGY AREA(S): Battlespace, Ground/Sea Vehicles

ACQUISITION PROGRAM: PMW/A 170 ACAT IC Navy Multiband Terminal; ACAT III Commercial Broadband Satellite Program

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 5.4.c.(8) of the solicitation. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop troposcatter control algorithms and control software that can compensate for ship motion and can overcome the communications limitations imposed by Anti-Access Area Denial (A2AD) environments.

DESCRIPTION: Anti-Access Area Denial (A2AD) environments impose significant communications threats from traditional jamming interferers to kinetic attacks on any communications relay vehicles. The A2AD threats continue to grow significantly each day rendering certain counter-counter measures less effective and, potentially, ineffective in the very near future. A2AD environment threats can be partially overcome via communications systems that do not rely on communication relays; these include Line of Sight (LOS) and Beyond Line of Sight (BLOS). Shipboard LOS communications, however, are generally limited to 15 miles which provides very limited ability to overcome A2AD environments for a vast majority of mission scenarios.

Troposcatter uses the troposphere as the reflection medium; thus, BLOS communications distances of 150 miles can be easily realized. Troposcatter typically utilizes narrow channel beams which provides inherent jam resistance and Low Probability of Detection (LPD). Troposcatter, therefore, can effectively provide communications capabilities for ships in A2AD environments. However, due to the amplitude fluctuation associated with mobile platform dynamics, troposcatter communications have been limited to “communications at the halt”. Shipboard dynamics is constant; thus, the notion of ‘at the halt’ is not possible for any Navy ship platforms. Recent work by Draper Laboratories indicates that the issue of platform dynamics can be addressed. Comtech has an existing troposcatter solution for relatively low dynamic marine oil and gas platforms to stationary shore site communications. There is no commercial system to the best of PMW/A 170’s knowledge that can address two dynamic platforms (ship to

ship) troposcatter communications.

A novel troposcatter control algorithm and ship motion compensation software that utilize existing shipboard Commercial Broadband Satellite Program (CBSP) C-band without imposing significant ship alternation is desired. The troposcatter control algorithm should be designed to maintain at least 10 Mbps of throughput with Bit Error Rate of 10^-5 or better. The troposcatter motion compensation software will also need to compensate for ship motion dynamics that range from World Meteorological Organization (WMO) sea state 0 (calm) to 5 (rough).

PHASE I: Determine technical feasibility for the development of troposcatter control algorithms and to increase communications capability for shipboard application, identify potential algorithms/software that can counter ship motion effects, and develop a strategy to realize troposcatter capabilities that maximize reuse of existing CBSP and a commercial off the shelf troposcatter modem (e.g., Comtech CS67500A) systems. Elements of the control algorithms can be considered for embedment in the future Navy Multiband Terminal (NMT) Wideband Anti-jam Modem (WAM) for CBSP application.

PHASE II: Based on the Phase I effort, develop, demonstrate and validate the counter ship motion effects algorithms for troposcatter communications on a representative CBSP like system to include C-band antenna control system meets the throughput and error rate requirements specified above. Produce an Interface Control Document (ICD) for the troposcatter antenna control system prototype that conforms maximally to the current CBSP C-band antenna control system.

PHASE III DUAL USE APPLICATIONS: Deliver at least two prototype software systems for demonstration and testing for ship-to-land communications. Additional ship-to-ship testing may be conducted. Support Navy efforts for integration and certification for use in the NMT and WAM for CBSP application. Private Sector Commercial Potential: Troposcatter for use on commercial ships and oil rigs to provide high capacity and low cost communications to both shore and afloat platforms.

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3. PMW/A 170 Communications Program Office SATCOM program overview. http://www.public.navy.mil/spawar/Press/Documents/Publications/1.25.12_AFCEA_Kit_IX.pdf

KEYWORDS: A2AD; PMW/A 170; Shipboard communications; Troposcatter; NMT; CBSP; C-band; NLOS; LOS; BLOS

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Questions may also be submitted through DoD SBIR/STTR SITIS website.

N162-136 TITLE: Sustained Maintenance Planning Software

TECHNOLOGY AREA(S): Materials/Processes

ACQUISITION PROGRAM: Strategic Systems Programs, ACAT I

OBJECTIVE: Develop innovative, predictive condition-based maintenance software to determine degradation and forecast production and refurbishment of hardware to reduce maintenance costs and increase operational availability.

DESCRIPTION: The acquisition program has an ongoing need to reduce total ownership costs and extend the life-cycle of components and systems to improve the reliability and overall operational readiness of the fleet. A cost effective method for ensuring component reliability is to augment the fixed schedule maintenance approach with deterministic component health and usage data to inform selective and targeted maintenance activities. The acquisition program seeks an innovative condition-based maintenance technology (i.e., a maintenance system that forecasts the health of the hardware) that can use adaptive learning techniques to "understand" component interdependencies and can accurately predict component failure of the system based on all available parametric data.

Innovative predictive software for forecasting the performance and maintenance of the hardware is required to address issues with the present method of maintenance. Currently, there is limited preventative maintenance that occurs on the hardware and is usually time-based and dependent upon human monitoring of systems. Hardware for this effort includes a two speed electric winch, wire rope, motor, brake, gearbox, and large metal structures. Computer-controlled test and monitor systems provide system status and allow for monitoring of key sub-system parameters such as fatigue, degradation, stress etc., but this data is not captured and thus not analyzed over time. Currently, preventative maintenance is not driven by automated system status or performance indicators and trends. Thus, maintenance is performed inefficiently and often fails to predict or prevent component and system failures.

Additionally, corrective hardware maintenance usually occurs after a component or system fails, or if component degradation is observed during routine maintenance. Failure to anticipate corrective maintenance requirements increases mean time to repair (MTTR), and decreases operational availability (Ao). Unanticipated corrective maintenance actions also drive up costs due to increased labor costs and expedited shipping costs when parts have to be obtained quickly.

Current software is not capable of making decisions but can be trained to improve its performance by factoring both technical decisions and programmatic decisions. An expert system that can use readily available, but not currently recorded, performance parameters to predict and thus preempt component and system failures is sought to improve overall system Ao, reduce MTTR, and reduce system maintenance and repair costs.

• Software should predict a failure, the inability or at least serious degradation of the hardware to perform its intended functions

o Software should determine the current degree of fault as quantified by Figure of Merit

o Prediction about the progression of the fault, in order to postulate the equipment's degree of fault as a particular point in time in the future

o Determine the level of the fault, as quantified by the FOM that will produce a failure of the platform.

• Software will be able to use inputs from historical and manufacturing data along with data from current sensors on the equipment.

• Software should be able to predict the life of the equipment

• Software should provide the dynamic variation/ uncertainty boundaries on the prediction

• Software should be able to use both supervised and unsupervised learning

• Software can include but not limited to linear regression, linear multiple regression, time series analysis, Bayesian dynamic linear models and non-linear regress and multiple regress

A desired, innovative solution is needed to expertly and continuously monitor the component parametric data streams and conduct trend analysis. The expert system would combine the trend analysis data with component degradation and failure data reports to improve its prediction algorithms. The desired result is a system that is capable of providing a report such as, "hardware A" has a 90% probability of failure within the next 72-96 operating hours" or "the output of component "B" decreased by 10% in the last 7 days with the rate of output decrease accelerating significantly in the last 24 operating hours, indicating there is an 89% probability of component failure

in the next 96 operating hours."

PHASE I: Define and develop a predictive condition-based maintenance forecaster that meets the requirements described above and demonstrate the feasibility of the concept against hardware. Perform analysis, modeling and simulation, or laboratory investigations/demonstrations to provide initial assessment of approach feasibility.

PHASE II: Develop a prototype based on Phase I for evaluation. Validation of the software should include apparent, internal and external validation. Internal validation should include calibration with the data used to construct the predictive software, assessment of discrimination with the data and use of bootstrap to generate bias-corrected estimates of calibration and discrimination.

PHASE III DUAL USE APPLICATIONS: Perform assessments on the hardware using data collected from in-situ sensors, hardware manufacturers and historical data in order to provide a long range maintenance plan. Software predictions will be compared to actual degradation and life of the equipment. Extend the use of this predictive condition-based maintenance forecaster to additional hardware components through future required development. Private Sector Commercial Potential: A predictive maintenance forecaster would improve the operational reliability of all hardware and improve their availability. Commercial hardware manufacturers would be able to incorporate the technology into their sustained maintenance planning. This is an innovative capability that can be used in any industry that needs to increase operational availability (Ao) and mean time to repair (MTTR).

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